Catalogue Data in Autumn Semester 2015

Agricultural Science Bachelor

Agricultural Science Practical

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<tr>
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<tr>
<td>751-0200-00L</td>
<td>Agricultural Science Practical</td>
<td>O</td>
<td>14</td>
<td>B. Dorn</td>
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Abstract: Das agrarwissenschaftliche Praktikum besteht aus dem Betriebsaufenthalt, der Betriebsaufnahme (Betriebsheft) und der agronomischen Fachaufgabe. Die Leistungskontrolle erfolgt über die Rückmeldung zu den einzelnen Bestandteilen des Praktikums.

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

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

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

1. Semester

First Year Examinations

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

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

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

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

Lecture notes: ca. 360 Seiten mit vielen Figuren und durchgerechneten Beispielen.

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

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<tr>
<td>401-0251-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>A. Cannas da Silva</td>
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Abstract: This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

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

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

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

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

Prerequisites / notice: Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

Assistance: Mondays 12-13, Tuesdays 17-19, Wednesdays 17-19, in Room HG E 41.

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<tr>
<td>551-0001-00L</td>
<td>General Biology I</td>
<td>O</td>
<td>3</td>
<td>3V</td>
<td>U. Sauer, A. Widmer</td>
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Abstract: Basics of structure, formation and function of cells and biomacromolecules, principles of metabolism, as well as basic classical and molecular genetics and evolutionary biology. First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.

Objective: The understanding of some basic principles of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its functions, as well as metabolism, inheritance and evolution.
The structure and function of biomacromolecules; basics of metabolism; cell biology; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, meiosis and sexual life cycles; Mendelian and molecular genetics; animal reproduction and behavior; sensory and motor mechanisms; population biology and evolution; principles of phylogeny.

The Campbell Chapters 1-4 (10th edition) under the heading “The role of chemistry in biology” are expected. We will treat the following Campbell chapters:

5 Biochemistry  Biological Macromolecules and Lipids
7 Cell biology  Cell Structure and Function
8 Cell biology  Cell Membranes
10 Cell biology  Cellular Respiration: An Introduction to Metabolism
10 Cell biology  Cellular Respiration
11 Cell biology  Photosynthesis
12 Cell Biology  Mitosis
13 The Genetic Basis of Life  Sexual Life Cycles and Meiosis
14 The Genetic Basis of Life  Mendelian Genetics
15 The Genetic Basis of Life  Linkage and Chromosomes
20 The Genetic Basis of Life  The Evolution of Genomes
21 Evolution  How Evolution Works
22 Evolution  Phylogenetische Rekonstruktion
23 Evolution  Microevolution
24 Evolution  Species and Speciation
25 Evolution  Macroevolution

Lecture notes
no script

Literature

Prerequisites / notice
The lecture is the first in a series of two lectures given over two semesters for students with biology as a basic subject.

101-0243-01L

Biology III: Essentials of Ecology

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

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

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

Literature
Generelle Ökologie:

Aquatische Ökologie:
Lampert & Sommer 1999. Limnökologie. Thieme, 2. Aufl., ca. Fr. 55.-
Bohle 1995. Limmische Systeme. Springer, ca. Fr. 50.-

Naturschutzbiologie:

701-0025-00L

Earth and Natural Production Systems

Abstract
The lecture provides a science-based exploration of key aspects of our planet: from its formation, to its properties and resources (minerals, soils, climate, water, vegetation), to agricultural production.

Objective
Overview and understanding of key aspects of planet earth and its role for agricultural production, including consideration of current challenges such as climate change, water crises, deforestation, north-south conflict and biodiversity.

Content
Origin of the planetary system, composition of the earth and the atmosphere, formation of continents and oceans, biogeochemical cycles, plate tectonics and earthquakes, erosion, climate, water cycle, surface waters, vegetation, forests and crops, food production including related worldwide ecological and economical interactions.

Lecture notes
Scripts provided by each teaching person.

Further information:
https://moodle-app2.let.ethz.ch/course/info.php?id=1682

701-0757-00L

Principles of Economics

Abstract
This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.

Objective
Students are able to
- describe fundamental micro- and macroeconomic issues and theories.
- apply suitable economic arguments to a given theme.
- evaluate economic measures.

Content
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomics policies

Lecture notes
available on electronic platform
A thorough study of all script materials is requested before the course starts. 

**Prerequisites / notice**

Electronic platform

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### Additional First Year Courses

#### 751-0013-00L World Food System

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<td>751-0013-00L</td>
<td>World Food System</td>
<td>O</td>
<td>4</td>
<td>4V</td>
<td>N. Buchmann, M. Kreuzer, M. Loessner, D. Moretti, M. Sonneveld, E. J. Windhab</td>
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</tbody>
</table>

**Abstract**

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

**Objective**

Attending this course, the students will recognize the elements of the World Food System (WFS) approach and the problems it is supposed to treat. They will especially comprehend the four pillars of global food security, namely (I) food availability (including sustainable production and processing), (II) access to food (physical and monetary), (III) food use (including quality and safety as well as the impact on human health and well being) and (IV) resilience to the boundary conditions (environmental, economic and political). This insight will make them aware of the global driving forces behind our food security and is expected to alleviate motivation and understanding for the association of subsequent specific courses within a general context. The course equivalently implements agricultural and food sciences, thus supporting the interdisciplinary view on the WFS scope.

**Content**

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

**Lecture notes**

Handouts and links are provided online.

**Literature**

Information on books and other literature references is communicated during the course.

**Prerequisites / notice**

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

The course is part of the block exam after the first study year. Paper copies can be used ("Open Book") during the on-line exam, but no other means are allowed. The course is taught in German.

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#### 751-0801-00L Biology I: Laboratory Exercises

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<td>E. B. Truernit</td>
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</table>

**Abstract**


**Objective**

Capability of preparing biological specimen, microscopy and documentation. Understanding the correlation between plant structure and function at the level of organs, tissues and cells. Awareness of the link between plant anatomy, systematics, physiology, ecology, and development.

**Content**


**Lecture notes**

Handouts

**Literature**

For further reading (not obligatory): Gerhard Wanner: Mikroskopisch-Botanisches Praktikum, Georg Thieme Verlag, Stuttgart.

**Prerequisites / notice**

Groups of a maximum of 30 students.

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#### 751-0001-00L Introduction to the Study Program

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<td>Lecturers</td>
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**Abstract**

Technical and organizational guidance to Freshmen.

**Objective**

Support to Freshmen in Agricultural Science and Food Sciences

**Content**

Information on: Program structure, regulations, bachelor thesis, project work, practice and the importance of first year basics. Organization: department, institutes, professorships and research, students' associations.

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#### 529-0030-00L Laboratory Course: Elementary Chemical Techniques

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<td>Laboratory Course: Elementary Chemical Techniques</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>N. Kober, M. Morbidelli</td>
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</table>

**Abstract**

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

**Objective**

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

**Content**

The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:

- Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvatation or precipitation processes) is studied.
- The synthesis of simple inorganic complexes or organic molecules is practised.
- Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

**Lecture notes**

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

**Literature**

A thorough study of all script materials is requested before the course starts.

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#### 252-0839-00L Informatics

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<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>L. E. Fässler, H.J. Böckenhauer, M. Dahinden, D. Komn</td>
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</table>

**Abstract**

Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: publishing over the internet, processing and visualizing time series, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to macro programming, universal methods for algorithm design.
Objective

The students learn to
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Content

1. Simulation and Modeling
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

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

Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through electronic tutorials and discussing their results with teaching assistants.

3. Semester

Basic Courses II: Examination Block 1

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<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
<td>A. Vaterlaus</td>
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<tr>
<td>Abstract</td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.</td>
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<tr>
<td>Objective</td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<tr>
<td>Content</td>
<td>Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Strahlenspektroskopie, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomene, Wärmestrahlung</td>
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<td>Lecture notes</td>
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<tr>
<td>Literature</td>
<td>Friedhelm Kuypers</td>
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<td>Physik für Ingenieure und Naturwissenschaftler</td>
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<td>Verlag Wiley-VCH, 2003, Fr. 77.-</td>
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<td></td>
<td>Douglas C. Giancoli</td>
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<td>Pearson Studium</td>
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<td>Hans J. Paus</td>
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<td>Physik in Experimenten und Beispielen</td>
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<td>Carl Hanser Verlag, München, 2002, 1068 S.</td>
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<td></td>
<td>Paul A. Tipler</td>
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<td>Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-</td>
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<td></td>
<td>David Halliday</td>
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<td>Robert Resnick</td>
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<td>Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03)</td>
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701-0071-00L Mathematics III: Systems Analysis O 4 credits 2V+1U N. Gruber, P. Landschützer

Abstract

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

Objective

Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.

Content

Content of lectures: http://www.up.ethz.ch/education/system_analysis/index_DE

Homework:
http://www.up.ethz.ch/education/system_analysis/SA2/index_DE

Lecture notes
Overhead slides:
http://www.up.ethz.ch/education/system_analysis/index_DE

Literature


752-4001-00L Microbiology O 2 credits 2V M. Ackermann, M. Schuppler, J. Vorholt-Zambelli

Abstract

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

Objective


Content

Wird von den jeweiligen Dozenten ausgegeben.

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

701-0255-00L Biochemistry O 2 credits 2V H.P. Kohler
Abstract
Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.

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

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

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

Prerequisites / notice
Basic knowledge in biology and chemistry is a precondition.

<table>
<thead>
<tr>
<th>Course Code</th>
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<tr>
<td>701-0500-00L</td>
<td>Pedosphere</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>R. Kretzschmar</td>
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<td>751-1101-00L</td>
<td>Finances and Accounting System</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>M. Dumondel</td>
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<tr>
<td>752-6003-00L</td>
<td>Introduction to Nutritional Science</td>
<td>O</td>
<td>2 credits</td>
<td>1.5V</td>
<td>M. B. Zimmermann, C. Wolfrum</td>
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<tr>
<td>751-1551-00L</td>
<td>Ressourcen- und Umweltökonomie</td>
<td>O</td>
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<td>2V</td>
<td>L. Bretschger, A. Müller</td>
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</tbody>
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Data: 06.12.2018 13:04  Autumn Semester 2015  Page 5 of 1432
Objective

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

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

Content

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

Lecture notes

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

Literature

- Water balance: http://www.tll.de/visuplant/vp_idx.htm
- Schubert S 2006 Pflanzenernährung Grundwissen Bachelor Ulmer UTB Pictures of nutrients deficiency symptoms: http://www.tll.de/visuplant/vp_idx.htm

Agricultural Natural Sciences

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
751-3401-00L | Anatomy and Physiology of Man and Animals I | O | 2 credits | 2V | M. C. Härdi-Landerer, S. E. Ulbrich
751-5101-00L | Plant Nutrition I | W | 2 credits | 2V | E. Frossard
751-4501-00L | Phytomedicine: Entomology | W | 1 credit | 1V | C. De Moraes

Abstract

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

The lecture consists of two consecutive parts.

Objective

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

Abstract

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

Objective

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

Content

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

Lecture notes

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

Literature

Phytomedicine: Plant Pathology

W  1 credit  1V  U. Merz, B. McDonald

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

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

Content

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

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

Animal Breeding

W  2 credits  2V  S. Neuenschwander

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

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

Content
Evolution, domestication, history of animal breeding.

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

Literature
Tierzucht (Willam/Simianer) UTB 3526 (2011)
Additional literature to be announced in the lecture.

Agricultural and Resource Economics

Number  Title  Type  ECTS  Hours  Lecturers
751-2001-00L  Area Planning and Regional Development  W  2 credits  2V  C. Lüscher, B. Buser

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

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

Content
Area Planning:
- Basics of area planning
- Overview over existing regulations in Switzerland
- State of the art in Switzerland
- links between area planning and environmental protection
regional development:
- Basics for a successful regional development based on personal field experience
- discussion of the different instruments
- stake holders and their role in regional politics
- case studies for developing strategies (in small study groups)

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

Literature
no literature
Prerequisites / notice
german spoken (with translation of french and italian technical terms)

751-1651-00L  World Food Economy and Agricultural Markets  W  2 credits  2V  R. Jörin

Abstract
Following microeconomic courses we teach in this course economic aspects of the world food situation and the international and national agricultural markets. It contains aspects of supply, demand, price determination, market structures and instruments of the agricultural trade.

Objective
Economic understanding of agricultural markets and the aspects of the world food problem.

Content
Part I: Principles of agricultural economics
Microeconomic analysis of supply, demand, and price determination in agricultural markets.
Part II: Aspects of globalization, development, natural resources and public health.
Part III: Analysis of selected agricultural and commodity markets: grains, oilseeds, sugar, ethanol and crude oil, milk and meat.

Lecture notes
Handouts (power point presentations)

Literature
Southgate. D. et al., 2010. The World Food Economy, Blackwell Publishing, Malden MA,USA

Focus Agricultural Natural Sciences

Number  Title  Type  ECTS  Hours  Lecturers
751-4001-00L  Forage Cropping  W+  2 credits  2G  N. Buchmann, A. Lüscher
Herbology

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

Objective
Die Studierenden werden wichtige Mischungen und Pflanzengeleichen mitteleuropäischer Grassandökosysteme kennen, klassische und aktuelle Arbeiten der Pflanzenökophysiologie kennen, in der Lage sein, den Einfluss von Umweltfaktoren und Bewirtschaftung nicht nur auf Einzelzüchter sondern auf Pflanzenbestände und ihre Eignung abzuschätzen, und üben, ein wissenschaftliches Thema schriftlich prägnant zusammenzufassen.

Content
In diesem Kurs werden die verschiedenen Typen des Futterbaus und die wichtigsten Mischungen, aber auch natürliche Pflanzengeleichen in Mitteleuropa vorgestellt (Bestandesbeurteilung). Basierend auf der Ökophysiologie von Einzelzüchter wird die Ökophysiologie von Pflanzenbeständen erarbeitet. Es werden verschiedene Arten der Bewirtschaftung vorgestellt (z. B. Bestandesanreicherung durch Düngung, Beweidung, Schnitterminer, etc.) und ihre Auswirkungen auf die Bestandeszusammensetzung und auf die Erträge diskutiert. Feedback-Mechanismen zwischen Umwelt und Futterbausystemen werden angesprochen.

Lecture notes
Handouts werden auf dem Netz zur Verfügung gestellt.

Literature
Wird in der Veranstaltung angesprochen.

Prerequisites / notice
Course will be given in German. Course builds on the Ertrags- und Ökophysiologie lecture and provides the basics for the Grasslandsystem.

751-4201-00L
Horticulture I

Abstract
Overview on horticulture (international and national), insights into principles of practical fruit production (pre- and post-harvest), viticulture (incl. some hints on wine making), berry production and vegetable production in Switzerland.

Objective
Insights into fruit production (world and Switzerland), particularly...
- Main production areas (international & national)
- Relevance (international & national)
- Key aspects of production (Switzerland), i.e. selected aspects referring to varieties, production techniques incl. physiology and plant protection, economics
- Key challenges (Switzerland)
- Selected, interesting research and development projects

Content
The relevance of horticulture at the international level will be treated in the first block. During the autumn semester (Horticultural Crops I), post harvest aspects in fruit production are discussed in 2 blocks of 4h. Following on this, viticulture (incl. some aspects of wine making) will be looked at in 3 blocks of 4h. During the spring semester (Horticultural Crops II), 3 blocks of 4h deal with vegetable production, and 2 blocks of 4h are addressing berry production.

Lecture notes
Delivered during the lectures by the different teachers. ELBA upload.

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

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

751-4701-00L
Applied Animal Nutrition

Abstract
The focus will be on the basic principles of biology and ecology of weeds, crop-weed interactions and basic knowledge of chemical, physical and biological weed control with their respective (dis-)advantages. Furthermore students will get an introduction on the mechanisms of weed management in different farming systems and crops.

Objective
The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.

Content
- Programmitte Wiederläufer: Einführung in die Winterfütterungsplanung für Milchkühe, Betriebsbesuch (Erfassung aller notwendigen Daten inkl. Futterprobenahme für eine konkrete Planung auf einem Praxisbetrieb), Besonderheiten der Milchviehfütterung (Laktationsverlauf, Jahreszeit, etc.); Einführung in den LBL-Fütterungsplan, Möglichkeiten der Futterbeurteilung und -bewertung mit praktischer Beurteilung der gesammelten Proben, Berechnungen und Besprechung Fütterungsplan, Aufstellung der Mineralstoffbilanz, Vorführung von PC-Software zur Fütterungsplanung Vorstellen und diskutieren des Fütterungsplanes auf dem Praxisbetrieb durch die Gruppe.
- Programmitte Wiederläufer: Der Energie- und spezifische Nährstoffbedarf beim Schwein und Geflügel; Besonderheiten der Fütterung in den verschiedenen Produktionsphasen; Fütterungsempfehlungen und -hinweise. Rationengestaltung und Rezeptoptimierung für Mischfuttermittel anhand verschiedener Beispiele; Einsatzgrenzen von Futtermittel; technologische Futterbearbeitung.

Lecture notes
Handouts in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung.

Literature
Die Dozierenden geben in der Lehrveranstaltung die relevante Literatur bekannt.

Prerequisites / notice
Blockkurs in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung.

751-7103-00L
Animal Feed and Feeding of Ruminant

Abstract
The knowledge of the nutrition of ruminants and of the feeds used is deepened. Particular emphasis is put on the variety of home-grown feeds, their production and conservation and their application in the nutrition of dairy cows, cattle and small ruminants. Finally, information on specific problems of animal nutrition is communicated.

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

Content
- Programmitte Wiederläufer: Einführung in die Winterfütterungsplanung für Milchkühe, Betriebsbesuch (Erfassung aller notwendigen Daten inkl. Futterprobenahme für eine konkrete Planung auf einem Praxisbetrieb), Besonderheiten der Milchviehfütterung (Laktationsverlauf, Jahreszeit, etc.); Einführung in den LBL-Fütterungsplan, Möglichkeiten der Futterbeurteilung und -bewertung mit praktischer Beurteilung der gesammelten Proben, Berechnungen und Besprechung Fütterungsplan, Aufstellung der Mineralstoffbilanz, Vorführung von PC-Software zur Fütterungsplanung Vorstellen und diskutieren des Fütterungsplanes auf dem Praxisbetrieb durch die Gruppe.
- Programmitte Wiederläufer: Der Energie- und spezifische Nährstoffbedarf beim Schwein und Geflügel; Besonderheiten der Fütterung in den verschiedenen Produktionsphasen; Fütterungsempfehlungen und -hinweise. Rationengestaltung und Rezeptoptimierung für Mischfuttermittel anhand verschiedener Beispiele; Einsatzgrenzen von Futtermittel; technologische Futterbearbeitung.

Lecture notes
Handouts in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung.

Literature
Die Dozierenden geben in der Lehrveranstaltung die relevante Literatur bekannt.

Prerequisites / notice
Blockkurs in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung.
Lecturers

J. Six

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

Lecture Topics and Tentative Schedule

Week 1: First day of autumn semester

Week 2: The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrphs, disease cycles and pathogen life cycles. Nemate attack strategies and damage.


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

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

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

Week 8: Pathogen effects on food quality and safety.

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

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

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

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

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

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

Lecture notes

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

Complementary Courses in Agricultural Natural Sciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-1307-00L</td>
<td>Managerial Economics Agri-Food Chain: Strategic Concepts</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>B. Höltzsch, M. Weber</td>
</tr>
</tbody>
</table>

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

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

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

Dokuments will be distributed per lecture.

Lecturer: A. Crole-Rees, U. Egger

Abstract
Development Economics II

Objective
The objectives of this course are to: understand the role of agriculture in the development process; learn about the relevant actors, the small-scale farmers, and how to integrate them into economic development and to be able to derive sound policy measures.

Content
Development economics II is a follow-up of "Development economics I".

The main topic is the role of agriculture and in the development process. The main features of this sector will be presented. In many developing countries that are at the beginning of economic development the largest share of the population is often involved in agriculture. In agriculture the production factor land is more important than in other sectors. Agriculture together with fisheries is the only sector that produces food. Food can either be produced locally or imported.

Farmers, even small-scale farmers, are integrated in the monetary world. Trade is very important for growth, food security and environment conservation.

The following topics will be tackled: role of agriculture in economic development, definition of sustainability, role of the various stakeholders in the agricultural sector.

Literature

Prerequisites / notice
Prerequisite: Attendance of introductory micro- and macroeconomics classes. Development economics I & II are one unit.

Number Title Type ECTS Hours Lecturers

751-0401-00L Operations Research: Linear and Non-Linear W+ 2 credits 3G S. Peter

Part 1: Agricultural building

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

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

Part 2: Work economics

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


### Programming

**Abstract**
Introduction in to the methods of Operations Research to solve conceptual tasks by means of mathematical models.

**Objective**
Gives an introduction in to the methods of Operations Research (OR) aiming to solve conceptual tasks by means of mathematical models.

**Content**
As a basic course for Operations Research (OR) the most important models and algorithms of OR will be worked out. A first part deals with the theory of linear programming (LP) (incl. duality). Practical excercises as well as on paper as on the computer serve to better understand the theoretical part of the course. The second part is about the basics of non-linear programming (NLP) (FOC, SOC, Lagrange, Kuhn-Tucker). Here as well, exercises help to improve the understanding of theoretical basics.

**Lecture notes**
Handed out during lecture

**Literature**
In the lecture one indicates

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
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<th>Authors</th>
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<td>751-1307-00L</td>
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<td>B. Höltschi, M. Weber</td>
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<tr>
<td>751-1501-01L</td>
<td>Development Economics II</td>
<td>2</td>
<td>W+</td>
<td>A. C. Crole-Rees, U. Egger</td>
</tr>
<tr>
<td>752-2120-00L</td>
<td>Consumer Behaviour I</td>
<td>2</td>
<td>W</td>
<td>M. Siegrist, C. Keller, B. S. Sütterlin</td>
</tr>
<tr>
<td>751-8001-00L</td>
<td>Agricultural Engineering I</td>
<td>2</td>
<td>W</td>
<td>M. Schick, M. Sax</td>
</tr>
</tbody>
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**751-1307-00L Managerial Economics Agri-Food Chain: Strategic Concepts**

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

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

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

**Lecture notes**
Dokuments will be distributed per lecture.

**Literature**
Lombriser Roman & Aplanalp Peter: Strategisches Management

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**751-1501-01L Development Economics II**

**Abstract**
The course is about the role of agriculture in economic development, definition of sustainability, role of the various stakeholders in the agricultural sector.

**Objective**
The objectives of this course are to: understand the role of agriculture in the development process; learn about the relevant actors, the small-scale farmers, and how to integrate them into economic development and to be able to derive sound policy measures.

**Content**
Development economics II is a follow-up of "Development economics I".

**Literature**

**Prerequisites / notice**
Prerequisite: Attendance of introductory micro- and macroeconomics classes. Development economics I & II are one unit.

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**752-2120-00L Consumer Behaviour I**

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

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

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**751-8001-00L Agricultural Engineering I**

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

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

**Subobjectives:**
- Basics in agricultural construction will show that a professional implementation of functional, animal-friendly, environmentally sound (and economically advantageous) construction of buildings is feasible.
- Profound knowledge of planning tools based on work economics will help the students to correctly plan the substitution of agricultural work by efficient technical solutions.
Part 1: Agricultural building
- Basics of structural engineering. Dimensioning of simple supported and cantilevered beams and roof structures. Tension, compression, bending.
- Evaluation of typical roof structures in agricultural buildings.
- Loads: snow, wind, dead and live loads
- Physical properties of building materials: timber, steel, concrete.
- Reinforcement of concrete
- Housing systems for cattle, pigs, poultry, horses
- Storage plants for slurry, manure, feed.
- Planning. Space and functioning programme, building concepts, financing, permit of building, detailed plans, contractors
- Planning and designing exercise.

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

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


751-0902-00L Microeconomics II W+ 2 credits 2V S. Briner
Abstract In the lecture different models of individual and firms’ decisions are presented. Above all it is discussed how firms behave under special conditions like mono- or oligopolies or under uncertain conditions.
Objective Acquisition of knowledge on advanced microeconomic approaches as well as their applicability on current economic problems and questions of human behavior
Content Theory & Examples on Game Theory, Oligopoly Theory, Asymmetric Information, as well as Production-, Exchange-, and Welfare-Analysis
Lecture notes Documents will be handed out during the semester

Complementary Courses in Agricultural and Resource Economics

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<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>N. Buchmann, A. Lüscher</td>
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</table>
Abstract This course is an introduction into forage cropping and grassland sciences. Topics include: extensive/intensive use, grassland evaluation, grassland maintenance, management using fertilization, cutting, etc. Relationships between site, vegetation composition and management will be explored.
Objective Die Studierenden werden wichtige Mischungen und Pflanzengemeinschaften mitteleuropäischer Graslandökosysteme kennen, klassische und aktuelle Arbeiten der Bestandesökophysiologie kennenlernen, in der Lage sein, den Einfluss von Umweltfaktoren und Bewirtschaftung nicht nur auf Einzelpflanzen, sondern auf Pflanzenbestände und ihre Erträge abzuschätzen, und üben ein wissenschaftliches Thema schriftlich prägnant zusammenzufassen.
Content In diesem Kurs werden die verschiedenen Typen des Futterbaus und die wichtigsten Mischungen, aber auch natürliche Pflanzengemeinschaften in Mitteleuropa vorgestellt (Bestandesbeurteilung). Basierend auf der Ökophysiologie von Einzelpflanzen wird die Ökophysiologie von Pflanzenbeständen erarbeitet. Es werden verschiedene Arten der Bewirtschaftung vorgestellt (z. B. Bestandeslenkung durch Düngung, Beweidung, Schnitttermine, etc.) und ihre Auswirkungen auf die Bestandeszusammensetzung und auf die Erträge diskutiert. Feedback-Mechanismen zwischen Umwelt und Futterbausystemen werden angesprochen.
Lecture notes Handouts werden auf dem Netz zur Verfügung gestellt.
Literature Wird in der Veranstaltung angesprochen.
Prerequisites / notice Course will be given in German. Course builds on the Ertrags- und Ökophysiologie lecture and provides the basics for the Graslandsysteme.

<table>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-4101-00L</td>
<td>Crops</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>A. Walter, F. Liebisch, W. Richter</td>
</tr>
</tbody>
</table>
Abstract Presentation of the central crops of our regions (cereals, oil and fibre plants, legumes, root and tuber plants) with respect to their biology, site requirements, reaction to environmental conditions and farming practice. A few crops of other regions will be discussed for these aspects as well.
Objective During this course, students acquire essential knowledge on agriculturally relevant aspects of crop biology. Via lectures and ‘hands-on’ teaching elements, differences between species as well as common aspects of different species will be experienced. Thereby, the foundation will be laid for a more intense examination of alternative crops, cropping systems and of procedures to characterize geno- and phenotype.

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-4201-00L</td>
<td>Horticulture I</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>L. Bertscinger, F. Gasser, J.L. Spring</td>
</tr>
</tbody>
</table>
Abstract Overview on horticulture (international and national), insights into principles of practical fruit production (pre- and post-harvest), viticulture (incl. some hints on wine making), berry production and vegetable production in Switzerland.
Objective Insights into fruit production (world and Switzerland), particularly ...
- Main production areas (international & national)
- Relevance (international & national)
- Key aspects of production (Switzerland), i.e. selected aspects referring to varieties, production techniques incl. physiology and plant protection, economics
- Key challenges (Switzerland)
- Selected, interesting research and development projects
Content The relevance of horticulture at the international level will be treated in the first block. During the semester in autumn (Horticultural Crops I), post harvest aspects in fruit production are discussed in 2 blocks of 4h. Following on this, viticulture (incl. some aspects of wine making) will be looked at in 3 blocks of 4h. During the spring semester (Horticultural Crops II), 3 blocks of 4h deal with vegetable production, and 2 blocks of 4h are addressing berry production.
Lecture notes Delivered during the lectures by the different teachers, ELBA upload.
Literature Not needed, maybe specific literature is specified by the different teachers.
Prerequisites / notice

751-4801-00L  System-Oriented Management of Herbivore Insects I  W  2 credits  2G  D. Mazzi
Abstract
The focus is on the potential to assess strategies and tactics of pest management, taking into account the demands from the economy, the environment and the society. Significant agricultural approaches will be explained using practical examples, including prevention using natural resources, surveillance and forecasting, resistance management, as well as product registration, incl. ecotoxicology.
Objective
The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.

Abstract
The basics of planning of feeding and formulation of diets incl. the implications on nutrient cycles and balances are taught. In the part dealing with ruminants, forage-based diets and the application of feed formulation programs are central and exercised on farm. With pigs and poultry, the basics of energy and nutrient requirements are deepened through practical examples.
Objective
The students are able, based on the knowledge they obtain in this course, to deal with problems in the nutrition of ruminants, pigs and poultry on farm.
Content
- Programmteil Wiederkäuer: Einführung in die Winterfütterungsplanung für Milchkühe, Betriebsbesuch (Erfassung aller notwendigen Daten inkl. Futterprobenentnahme für eine konkrete Planung auf einem Praxisbetrieb), Besonderheiten der Milchviehfütterung (Laktationsverlauf, Jahreszeit, etc.); Einführung in den LBL-Fütterungsplan, Möglichkeiten der Futterbeurteilung und –bewertung mit praktischer Beurteilung der gesammelten Proben, Berechnungen und Besprechung Fütterungsplan, Aufstellung der Mineralstoffbilanz, Vorführung von PC-Software zur Fütterungsplanung Vorstellen und diskutieren des Fütterungsplanes auf dem Praxisbetrieb durch die Gruppe.

Lecture notes
Handouts in German language will be provided by each lecturer when starting his part of the lecture.
Prerequisites / notice
Blockkurs in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung.

751-5003-00L  Sustainable Agroecosystems II  W  2 credits  2V  J. Six, A. Hofmann
Abstract
This class is intended to convey methods of agroecological research through selected case studies from current research projects and hands-on exercises. Students will gain an overview on actors in the field of sustainable agricultural development.
Objective
(1) Get to know methods for field and laboratory investigations in agroecology, (2) Analyze case studies from current agroecological research, (3) Place institutions and related projects into the context of sustainable agricultural development
Literature
Prerequisites / notice
Prior participation in the lecture Nachhaltige Agrarökosysteme I (Sustainable Agroecosystems I) 751-5000-00G (in spring semester) recommended; classes taught mostly in English

751-4504-00L  Plant Pathology I  W  2 credits  2G  F. Talas, B. McDonald, J. Palma Guerrero, A. Sanchez Vallet
Abstract
Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems
Objective
Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

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


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

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

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

Week 8  Pathogen effects on food quality and safety.

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

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

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

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

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

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

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

Methodical Courses

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-1010-00L</td>
<td>Introduction to Scientific Writing in Agricultural Science</td>
<td>O</td>
<td>2 credits</td>
<td>4G</td>
<td>B. Dorn, N. Buchmann, A. K. Gilgen</td>
</tr>
<tr>
<td>Abstract</td>
<td>Die Studierenden kennen die Grundlagen und die Konventionen des wissenschaftlichen Schreibens in den Naturwissenschaften, können wissenschaftliche Literatur suchen und verwalten sowie wissenschaftliche Publikationen analysieren.</td>
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<tr>
<td>Objective</td>
<td>Die Studierenden kennen die Grundlagen und die Konventionen des wissenschaftlichen Schreibens in den Naturwissenschaften, können wissenschaftliche Literatur suchen und verwalten sowie wissenschaftliche Publikationen analysieren. Die Studierenden setzen das Gelernte beim Schreiben eines Textes in deutscher Sprache zu einem agrarwissenschaftlichem Thema ihrer Wahl um. Die Lehrveranstaltung bereitet die Studierenden auf weitere schriftliche Arbeiten im Studium der Agrarwissenschaften vor, beispielsweise auf die Bachelor- und Master-Arbeiten.</td>
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<tr>
<td>Lecture notes</td>
<td>Es werden Vorlesungskräfte abgegeben. Link auf die Webseite mit Informationen und Dokumenten zur Lehrveranstaltung.</td>
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</table>

| 751-0441-00L | Scientific Analysis and Presentation of Data  | O    | 2 credits | 2G  | W. Eugster                |
| Abstract  | This lecture gives an introduction to the scientific work with data (from data acquisition to statistical analyses and their graphical presentation). Getting organized with a spreadsheet program (OpenOffice, Excel) and being able to analyse the data in the open-source R package will be the primary focus. Field data gathered with Prof. E. Frossard in the previous semester are used. |
| Objective | This lecture with exercises gives an introduction to the scientific work with data, starting with data acquisition and ending with statistical analyses as they are often required for a bachelor thesis (descriptive statistics, linear regression etc.). Getting organized with a spreadsheet program (OpenOffice, Excel) and being able to analyse the data in the open-source R package will be the primary focus. An important aspect will be to learn which graphical representation of data are best suited for the task (how can data be presented clearly and still scientifically correct?) |

Link auf die Webseite mit Informationen und Dokumenten zur Lehrveranstaltung: http://www.usys.ethz.ch/agr/bachelor/wis
Content

Tentative Programme:
1. Introduction
2. Data acquisition, data organization, data storage, working with data
3. Graphical presentations I - Spreadsheets
5. Correct and problematic graphical data displays
6. Introduction to 'R'
7. Data import and graphical presentation
8. Statistical distribution and confidence intervals
9. Statistical tests - Repetition and hands-on applications
10. Linear regressions
11./12. Analysis of Variance
13. ANOVA - Discussion of results with Prof. E. Frossard

Last week of semester: examination (Leistungskontrolle)

Lecture notes

German

Prerequisites / notice

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

Bachelor Thesis

Number Title Type ECTS Hours Lecturers
751-1020-00L Bachelor’s Thesis O 14 credits 60D Lecturers

Abstract
Please contact the Study Administration for registration.

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

Content
The independent writing of a scientific paper/thesis

Complementary Courses

No acquisition of credits

Number Title Type ECTS Hours Lecturers
760-0001-00L Colloquium Master in Agricultural Science E- 0 credits 2K Lecturers

Agricultural Science Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Suitable for doctorate</td>
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</table>

Key for Hours

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<tr>
<th>Key</th>
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<td>V</td>
<td>lecture</td>
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<td>lecture with exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is voluntary.

Coping with Psychosocial Demands of Teaching (EW4)

E. Stern

- Understand research methods used in the empirical educational sciences
- Understand pedagogically relevant findings from the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Getting to know intelligence tests
- Get to know cognitively activating instructions in MINT subjects
- Understanding  findings relevant for education
- Getting to know empirical studies on human learning and relates them to the school.

Abstract

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

Objective

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

Content

Themenliche Schwerpunkte:

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

Lernformen:


Lecture notes

Folioren werden zur Verfügung gestellt.

Literature


Prerequisites / notice

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

Cognitively Activating Instructions in MINT Subjects ■ W

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

Number of participants limited to 30.

Abstract

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

Objective

- Get to know cognitive activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice

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

Human Intelligence

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

Number of participants limited to 30.

Abstract

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

Objective

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

Research Methods in Educational Science

Number of participants limited to 30.

Abstract

Literature from the learning sciences is critically discussed with a focus on research methods.

Objective

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

Coping with Psychosocial Demands of Teaching (EW4 W DZ) ■

Number of participants limited to 20.
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching.

Abstract

Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

Objective

1. They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
2. They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-9020-00L</td>
<td>Teaching Internship Including Examination Lessons</td>
<td>W</td>
<td>6</td>
<td>13P</td>
<td>G. Kaufmann</td>
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<td>Agricultural Science</td>
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<tr>
<td></td>
<td>Only for students who enrolled from HS 2011 on into TC.</td>
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</table>

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

Abstract

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

Objective

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

Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content


The Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriterienbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Further Subject Didactics

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

Abstract

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

Objective

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

Content

Thematic Schwerpunkte:

Lernformen:

Literature

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

<table>
<thead>
<tr>
<th>Key for Hours</th>
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<tbody>
<tr>
<td>V</td>
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<td>K</td>
<td>colloquium</td>
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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Ruminant Science (HS)

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

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

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

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

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

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

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

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

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

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

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

### Ruminal Digestion

**Number**: 751-7211-00L  
**Title**: Ruminal Digestion  
**Type**: W+  
**ECTS**: 1 credit  
**Hours**: 1G  
**Lecturer**: A. Schwarm

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

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

**Content**  
Structure of the contact hour part of the course (14 h):  
2 h Introduction and blackboard exercise  
8 h Basic topics in ruminal digestion:  
- Systematics of the microbes involved in microbial digestion  
- Measurement of microbial digestion  
- Interactions of microbes and epithelium of the digestive tract  
- Differences between ruminal and hindgut microbial digestion  
- Microbial nutrient degradation and its modification  
- Efficiency of microbial protein synthesis  
- Manipulation of the ruminal digestion  
2 h Laboratory exercise with a rumen fistulated cow and the Rumen Simulation Technique

2 h Concluding seminary

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

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

**Literature**  
Will be communicated at the start of the course.
In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and the lecturers.

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

- **Element 1. Oral Presentation:** The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.
- **Element 2. Scientific writing:** Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion in small groups at two dates.

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

The course includes a credits association with either a written report or a short oral presentation in the concluding seminar (both on a self-chosen topic).

### Non-Ruminant Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-6601-00L</td>
<td>Pig Science (HS)</td>
<td>W+</td>
<td>3 credits</td>
<td>3V</td>
<td>E. Hillmann, M. C. Härdi-Landerer</td>
</tr>
</tbody>
</table>

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

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

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

**Course Prerequisites / Notice**

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

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

### Livestock in the World Food System

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-6001-00L</td>
<td>Forum: Livestock in the World Food System</td>
<td>W+</td>
<td>2 credits</td>
<td>1S</td>
<td>M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander</td>
</tr>
</tbody>
</table>

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

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

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

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

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

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

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

**Lecture notes**
No script

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

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-7703-00L</td>
<td>Tropical Animal Nutrition</td>
<td>W+</td>
<td>1 credit</td>
<td>1G</td>
<td>M. Kreuzer, M. Buchmann</td>
</tr>
</tbody>
</table>

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

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

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

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-6901-00L</td>
<td>Niches in Animal Production</td>
<td>W+</td>
<td>1 credit</td>
<td>1G</td>
<td>M. Kreuzer, M. Buchmann</td>
</tr>
</tbody>
</table>
This course deals with unconventional animals or production forms and specific aspects of for keeping them in Europe or, more specifically, in Switzerland. This includes e.g. rare breeds, wild cattle, deer, camelds, ostrich and fish. Particular emphasis will be given to the regulations and the problems occurring with import, housing and marketing of the products.

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

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

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

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

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

Scheduled dates of the course for 2011:
- Theory part: Monday 29 October 2012
- Excursion: Monday 5 November 2012
- The date of examination is to be coordinated between lecturers and students

### Animal Health and Genetics

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-6305-00L</td>
<td>Livestock Breeding and Genomics I</td>
<td>W+</td>
<td>2 credits</td>
<td>1V</td>
<td>B. Gredler, P. von Rohr</td>
</tr>
<tr>
<td>Abstract</td>
<td>Methods for analysing livestock data, in particular for the estimation of breeding values: principles of selection index, correction of records for fixed effects, introduction to BLUP, application of common models used, relationship matrix, methods for the estimation of variance components. The material will be illustrated via exercises and assignments.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The students are able to estimate breeding values for the most common population structures using the selection index. They are able to set up design matrices, the relationship matrix and its inverse as well as the Mixed Model equations to estimate BLUP breeding values for smaller examples.</td>
<td></td>
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<tr>
<td>Content</td>
<td>Selection index (various sources of information, one trait, multiple traits)</td>
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<tr>
<td></td>
<td>Relationship matrix and its inverse</td>
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<tr>
<td></td>
<td>Correction of fixed effects</td>
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<tr>
<td></td>
<td>BLUP: one trait, repeated observations, multiple traits, economic indices</td>
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<tr>
<td></td>
<td>Introduction to methods for the estimation of variance components</td>
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<tr>
<td></td>
<td>Assignments</td>
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</tr>
<tr>
<td>Literature</td>
<td>Copies of the slides are available on the net.</td>
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<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>To be announced in the lectures.</td>
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</table>

| 751-7603-00L | Livestock Breeding and Genomics II         | W+    | 1 credit | 1V    | B. Gredler, P. von Rohr         |
| Abstract     | The course provides methods to use molecular genetics information in livestock breeding. First, linkage disequilibrium, its measurement and applications are introduced. Genomic selection, genome wide association studies, and estimation of breeding values are further topics. The theory is applied in assignments. |       |       |       |                                 |
| Objective    | The students are able to interpret and apply linkage disequilibrium. They are able to discuss the principles of genomic selection, genome wide association studies and breeding value estimation. |       |       |       |                                 |
| Content      | Linkage disequilibrium                     |       |       |       |                                 |
|              | Genomic selection and estimation of breeding values |       |       |       |                                 |
|              | Genonomwide association studies             |       |       |       |                                 |
|              | Assignments                                |       |       |       |                                 |
| Literature   | Copies of the slides are available on the net. |       |       |       |                                 |
| Lecture notes| To be announced in the lectures.           |       |       |       |                                 |

| 751-6243-00L | Conservation of Animal Genetic Resources  | W+    | 1 credit | 1V    | H. Signer-Hasler               |
| Abstract     | Conservation of Animal Genetic Resources overviews the distribution, endangerment and conservation of farm animal genetic resources in Switzerland and abroad. The theory is illustrated with numerous examples and the knowledge is deepened in exercises. |       |       |       |                                 |
| Objective    | The students can explain differences between species and breeds concerning biodiversity conservation. |       |       |       |                                 |
|              | can describe different conservation activities, in particular in situ and ex situ conservation |       |       |       |                                 |
|              | can describe current national and international conservation programmes for species and breeds. |       |       |       |                                 |

### Endocrinology and Reproduction

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

### Methodology Competences

### Methods in Animal Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>751-6113-00L</td>
<td>Endocrinology and Biology of Reproduction</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>S. E. Ulbrich</td>
</tr>
<tr>
<td>Abstract</td>
<td>Endokrinologie und Reproduktionsbiologie der Säugetiere und des Menschen (Anatomie, Morphologie, Physiologie, Regelmechanismen) Die Systematik der Reproduktionshormone und der Hormonrezeptoren wird erläutert, die Wirkungsmechanismen (Bildung; orale Bioverfügbarkeit; Elimination) erklärt. Bei diesen Grundlagen wird das Verständnis der Regulation der Fortpflanzung umfassend erörtert.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Die Studierenden erlangen das grundlegende theoretische Verständnis und Fachwissen zur Endokrinologie der Reproduktion und zur weiblichen und männlichen Reproduktionsbiologie. Sie können darüber hinaus pathologische Situationen (Fortpflanzungsstörungen) und deren vielfältige Ursachen in den physiologischen Kontext einordnen.</td>
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<tr>
<td>751-6241-00L</td>
<td>Laboratory Practical in Molecular Animal Genetics and Inherited Diseases</td>
<td>W+</td>
<td>3 credits</td>
<td>3P</td>
<td>S. Neuenchwander, A. Bratus-Neuenchwander, C. Schelling</td>
</tr>
<tr>
<td>Abstract</td>
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<tr>
<td>Objective</td>
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</table>
Introduction to the course (aims, program, written examination)

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

Specific literature will be indicated individually by the lecturers.

### Literature


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

The tentative schedule containst the following topics:

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

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

### Project Management and Presentation Skills

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-3011-00L</td>
<td>Improvement of Oral and Written Skills</td>
<td>W+</td>
<td>4</td>
<td>4S</td>
<td>U. Merz, E. Buff Keller, P. Mayer</td>
</tr>
</tbody>
</table>

**Number of participants limited to 21.**

**Abstract**

- Acquiring competence in
  - searching, analyzing and synthesizing scientific information on a specific subject
  - writing a scientific paper
  - making a scientific oral presentation, alone (with poster) and with the team
  - animating and moderating a discussion (teamwork)

**Objective**

- Acquiring competence in
  - searching, analyzing and synthesizing scientific information on a specific subject
  - writing a scientific paper
  - making a scientific oral presentation, alone (poster) and with the team
  - animating and moderating a discussion (teamwork)

**Content**

- Workshops
  - how to make a poster
  - how to present (with video-feedback)
  - how to moderate a discussion
  - scientific writing (different types of documents)
  - individual assessment:
    - make a poster and present it
    - write a review or a statement
    - team assessment:
    - write a recommendation (executive summary)
    - present the recommendation
    - moderate a discussion

**Lecture notes**

No script, but div. Instructions

**Literature**

see website

### Major in Crop Science

##### Disciplinary Competences

##### Cropping Systems

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

**Abstract**

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

**Objective**

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

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

**Content**

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

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

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

**Lecture notes**

Documents handed out during the case studies.

**Literature**

As provided by the case study leaders.

**Prerequisites / notice**

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

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

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>A. Walter, B. Büter</td>
</tr>
</tbody>
</table>

**Abstract**

Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.
Objective
During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. Wikipedia-entries will be generated.

751-3603-00L Plant Breeding II

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<tr>
<th>Number</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-3603-00L</td>
<td>Plant Breeding II</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>A. Hund, B. Studer</td>
</tr>
</tbody>
</table>

Abstract
The course consists of two parts. First, important plant breeding concepts such as, molecular breeding and genetic engineering but also organic and participatory breeding are introduced and discussed. Furthermore, we look at the legislation affecting these concepts. Second, the application of different plant breeding methodologies and their effect on the evolution of major crops are highlighted.

Content
In the first part of the course, we will discuss most important plant breeding tools and concepts. The lectures include lessons on genetic engineering utilizing genetic variation across species; organic plant breeding focussing on the need of organic agriculture; participatory plant breeding involving farmers in the breeding progress as well as genomic selection using a genome-wide coverage of molecular markers to predict the performance of a genotype. You will learn how new marker technologies and breeding tools in combination with precise phenotyping may influence the breeding progress in the future and how knowledge of the genetic architecture of crops can be utilized for selection. Furthermore, we will cover the legislation around the conservation of crop genetic resources for food and agriculture (PGRFA), the plant breeding rights (UPOV), gene patenting and the release of genetically modified organisms into the environment.

Differences in legislation on worldwide scales, in Europe and in Switzerland will be highlighted. At the end of this section, you will be able to critically discuss the pros and cons of different concepts of plant breeding ranging from organic and participatory breeding to genetic modification and gene patenting.

In the second part of the course, you will learn most important aspect of crop evolution and breeding of maize, wheat, rapeseed, sugar beet, potatoes and forage crops. This includes: the most important domestication traits; crop evolution; genetics and cytogenetic, reproductive biology, germplasm resources; major breeding aims and common breeding methods. At the end of this section you will be able to discuss the most important achievement of our major crops in a plant breeding context.

Prerequisites / notice
The participation in this course requires a basic understanding of plant breeding as taught in ‘Pflanzenzüchtung 1’ (formerly Pflanzengenetik), or similar lectures at other universities.

Crop Health

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0263-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious Diseases</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
</tr>
<tr>
<td>751-4811-00L</td>
<td>Alien Organisms in Agriculture</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>J. Collatz, M. Meisie</td>
</tr>
</tbody>
</table>

Agriculture and Environment

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-5101-00L</td>
<td>Biogeochemistry and Sustainable Management</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>L. Merbold, N. Buchmann</td>
</tr>
</tbody>
</table>
Content
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

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

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

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

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

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

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

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

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

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

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

751-5001-00L Agroecologists without Borders
W 2 credits 2S C. Decock, A. Hofmann, J. Six

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

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

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

751-5201-00L Tropical Soils and Land Use
W 2 credits 2G J. Six

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

751-4506-00L Plant Pathology III
W 2 credits 2G U. Merz, M. Maurhofer Bringolf

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

Objective
(1) The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogen, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture.
(2) Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

751-4805-00L Recent Advances in Biocommunication
W+ 2 credits 2S C. De Moraes

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

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

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

Methodology Competences

Methods in Agricultural Sciences

Number Title Type ECTS Hours Lecturers
751-4506-00L Plant Pathology III W 2 credits 2G U. Merz, M. Maurhofer Bringolf

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

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

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

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

Lecture notes
Documents will be distributed during the lecture

Literature
Will be given during the lecture

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

751-5123-00L Rhizosphere Ecology
W+ 4 credits 4G
H. A. Gamper,
E. K. Bünemann König,
T. I. McLaren

Abstract
This course emphasizes interactions among physicochemical and biological processes and highlights implications for plant nutrition, growth, and health. Nutrient mobilization and acquisition by plants in response to fertilization, other plants, and microbes, are explored in model systems. Newly gained knowledge is applied to understand results of a pot experiment and thereby critically reflected.

Objective
To gain a holistic understanding of resource-driven and regulatory processes in natural and agronomic plant-microbe-soil systems.
To practice abilities to read scientific literature, understand it, present it, and discuss it with peers.
To combine available and newly acquired knowledge from soil physics, chemistry and (micro-)biology, plant physiology, pathology, and ecology and reflect on their relative importance for plant production, bio remediation, and nature conservation when considered together.
To practice manual skills in handling seedlings, soil, plant, and DNA samples, laboratory equipment, and working with different computer software.
To make observations, analyse, display, interpret and present own data.
To get familiar with (bio-)chemical, molecular genetic, and simple bioinformatics analyses.
To prepare as a group of course participants a poster on one selected aspect of a bigger pot experiment, present it, and discuss findings and posters of other course participants.
To combine findings with available knowledge, generate explanatory hypotheses, and identify potentially informative further analyses and experiments.

Content
This course comprised lectures, the set-up, harvest and data analysis of an experiment, soil (bio-)chemical, microbiological and molecular genetic analyses in the laboratory and practical computational data analyses. The focus is set on a better understanding of the role played by spatial and temporal physicochemical and microbiological gradients and various soil organisms in plant mineral nutrition. Mutualistic associations between plant roots and microbes, such as the root symbiosis with mycorrhizal fungi and root nodule-inducing bacteria are discussed. Rhizobia are isolated from field-collected root nodules and characterized, using molecular genetic tools. A short introduction into DNA-based bioinformatics and phylogenetic analyses is given to demonstrate how bacterial species are identified and potential host ranges of isolated rhizobia can be inferred, using so-called functional genes. A pot experiment in the glasshouse on cereal-legume mixed intercropping, including effects of pot size, intra- and interspecific plant competition, and root traits, allows to relate scientifically interesting research topics to practical application, while simultaneously stimulating critical reflections.

Lecture notes
Lecture slides and laboratory protocols are being made available in the directory ‘751-5123-00L Rhizosphere Ecology’ of the electronic document exchange platform ILIAS, LDA-ELBA:
https://ilias-app2.let.ethz.ch/ilias.php?ref_id=85894&cmdClass=ilrepositorygui&cmdNode=el&baseClass=ilRepositoryGUI
Prerequisites / notice

For students of the Agricultural Sciences of D-USYS: Lectures in Plant Nutrition I and II (Nutrient cycling in agroecosystems by Prof. E. Frossard).

We ask all other course participants to read and understand the e-learning module Plant Nutrition I by Prof. E. Frossard:
https://moodle-app2.let.ethz.ch/course/view.php?id=279

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

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

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

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

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

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

**Design, Analysis and Communication of Science**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-3011-00L</td>
<td>Improvement of Oral and Written Skills</td>
<td>W+</td>
<td>4 credits</td>
<td>4S</td>
<td>U. Merz, E. Buff Keller, P. Mayer</td>
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<td>Number of participants limited to 21.</td>
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<td>- searching, analyzing and synthesizing scientific information on a specific subject</td>
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<td>- writing a scientific paper</td>
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<td>- making a scientific oral presentation, alone (with poster) and with the team</td>
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<td>- animating and moderating a discussion (teamwork)</td>
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<td>- Workshops</td>
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<td>- how to make a poster</td>
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<td>- how to present (with video-feedback)</td>
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<td>- how to moderate a discussion</td>
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<td>- scientific writing (different types of documents)</td>
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<td>- individual assessment</td>
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<td>- make a poster and present it</td>
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<td>- moderate a discussion</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<td>In this course, different experimental designs will be discussed and various statistical tools will be applied to research questions in agroecosystem sciences. Both manipulative (field and laboratory) experiments and surveys are addressed and students work with a selection of basic techniques and methods to analyse data using a hands-on approach. Methods range from simple t-tests to multi-factoria</td>
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<td>Students will know various statistical analyses and their application to science problems in their study area as well as a wide range of experimental design options used in environmental and agricultural sciences. They will practice to use statistical software packages (R), understand pros and cons of various designs and statistics, and be able to statistically evaluate their own results as well as those of published studies.</td>
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<td>The course program uses a learning-by-doing approach (&quot;hands-on minds-on&quot;). New topics are introduced in the lecture hall, but most of the work is done in the computer lab to allow for the different speeds of progress of the student while working with data and analyzing results. In addition to contact hours exercises must be finalized and handed in for grading. The credit points will be given based on successful assessments of selected exercises.</td>
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<td>The tentative schedule containst the following topics:</td>
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<td>Introduction To Experimental Design and Applied Statistics</td>
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<td>Design of Field and Growth Chamber Experiments</td>
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<td>Multivariate Techniques: Principle Component Analysis, Canonical Correspondence Analysis (CCA), Cluster Analysis</td>
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<td>Error Analysis, Error Propagation and Error Estimation</td>
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<td>The course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.</td>
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**Major in Food and Resource Use Economics**

**Disciplinary Competences**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-1555-00L</td>
<td>Food Economics</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>A. Champetier de Ribes</td>
</tr>
</tbody>
</table>

Food Economics proposes to explore important issues in food production, supply, and consumption using the concepts and tools of microeconomics.
The two objectives of the class are:
- to provide an overview of the important issues related to food markets and supply chains.
- to present the economics concepts and tools that are useful to understand the functioning of food supply chains under various governance regimes or policies (emphasis on welfare analysis)

The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include:
- Demand for food.
- Matching demand with supply.
- Industrial organization in the food supply chain.
- Non-quality attributes of food.
- When information is costly.
- Food production and the environment.
- The food sector within human economies.

In addition, the students collectively identify and address an applied research question. We implement an empirical strategy to tackle the question before results are discussed individually by students during the final written examination.

Students are expected to master basic microeconomics concepts such as demand, supply, or consumer and producer surplus. We will review lecture the following contents will be treated:
- ... to present the economics concepts and tools that are useful to understand the functioning of food supply chains under various governance regimes or policies (emphasis on welfare analysis)

The course provides an overview about the following topics: Factors influencing consumer’s food choice, food and health, attitudes towards food products.

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

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The two objectives of the class are:
- deepen the relevant topics in an autonomous way.
- know possible practical applications and examples of the treated contents to organizations in the Agri-Food Chain and beyond.
- know and can apply selected comprehensive models for managing in complex situations,
- know the characteristics and consequences of complexity in the organizational world,
- be able to identify the main challenges and opportunities for environmental governance and to critically discuss them.

The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include:
- Demand for food.
- Matching demand with supply.
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Students are expected to master basic microeconomics concepts such as demand, supply, or consumer and producer surplus. We will review lecture the following contents will be treated:
- ... to present the economics concepts and tools that are useful to understand the functioning of food supply chains under various governance regimes or policies (emphasis on welfare analysis)
The course focuses on agricultural economic research with particular focus on policy evaluation. We impart insights in the issue of policy evaluation as part of agricultural economics research.

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

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

851-0594-00L International Environmental Politics W 4 credits 2V T. Bernauer Particularly suitable for students of D-ITET, D-USYS

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

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

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

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

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Lecture notes
Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your NetID username and password to access the material.

Literature
Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The workload for this course is approx. 120 hours (all inclusive).

Agricultural Trade and Policies

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>751-2401-00L</td>
<td>Food and Agricultural Trade Policy</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>R. Jörin</td>
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<tr>
<td>751-2903-00L</td>
<td>Evaluation of Agricultural Policies</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>M. Stolze, S. Mann</td>
</tr>
</tbody>
</table>

Abstract
The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution. By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.

Objective
1. Knowledge of the mechanisms of agricultural trade
2. Impact of trade policy instruments on welfare and distribution
3. Specific aspects of agricultural trade and links to other courses:
   - Trade and food security
   - Trade and environment
   - Trade and development

Content
The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution. By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.

Lecture notes
Handouts (power point presentations)

Literature
Objective Focus: Policy Evaluation

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

Content

Unit: Subject

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

Lecture notes

Handouts (power point presentations)

Literature

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

Prerequisites / notice

Unit 08: 1 day course at ART in Tänikon, 8356 Ettenhausen, www.art.admin.ch
Unit 09: 1 day course at FiBL in 5070 Frick, www.fibl.org

Methods and Procedures

Methods in Food and Resource Use Economics

Number Title Type ECTS Hours Lecturers


Abstract

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

Objective

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

Content

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

The tentative schedule contains the following topics:

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

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

Lecture notes

Handouts will be available (in English)

Literature

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

Prerequisites / notice

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

363-0541-00L Systems Dynamics and Complexity

Abstract

Finding solutions: what is complexity, problem solving cycle.

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

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

Objective

A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics
Content
Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.
The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

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

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

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

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

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

<table>
<thead>
<tr>
<th>401-0647-00L</th>
<th>Introduction to Mathematical Optimization</th>
<th>W+</th>
<th>5 credits</th>
<th>2V+1U</th>
<th>R. Zenklusen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to basic techniques and problems of mathematical optimization.</td>
<td></td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Topics covered in this course include:</td>
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<td></td>
<td>- Linear programming (simplex method, duality theory, shadow prices, ...).</td>
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<td></td>
<td>- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Information about relevant literature will be given in the lecture.</td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>This course is meant for students who did not already attend the course &quot;Mathematical Optimization&quot;, which is a more advance lecture covering similar topics and more.</td>
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<table>
<thead>
<tr>
<th>751-0423-00L</th>
<th>Risk Analysis</th>
<th>W+</th>
<th>2 credits</th>
<th>2G</th>
<th>to be announced</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Modern world is characterized by an increasing complexity, with decision-makers being confronted with many challenges and sources of uncertainty and risk. The course Risk Analysis aims at establishing a more comprehensive understanding of risk and risk sources as well as teaching student in risk appraisal and risk management.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>to develop a better understanding of decision making under uncertainty and risk;</td>
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<td>to brief in methods for the analysis of risky decisions.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Risk and risk measurement;</td>
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<td></td>
<td>Risk preferences;</td>
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<td></td>
<td>Expected utility theory;</td>
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<tr>
<td></td>
<td>Mean-variance approach;</td>
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<td></td>
<td>Stochastic dominance criterion;</td>
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<td></td>
<td>Portfolio optimization (risk efficient frontier);</td>
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<td>State-contingent approach;</td>
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<td></td>
<td>Utility-efficient modeling;</td>
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<td></td>
<td>Stochastic processes;</td>
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<tr>
<td></td>
<td>Bayesian inference.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts will be distributed in the lecture and available on the moodle.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>References to the relevant literature will be made in the course</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>- knowledge of basic concepts of probability theory;</td>
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<td></td>
<td>- basic programming skills in R or any other programming language.</td>
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<table>
<thead>
<tr>
<th>751-0422-00L</th>
<th>Econometrics II</th>
<th>W+</th>
<th>2 credits</th>
<th>2G</th>
<th>P. Stalder</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to Econometrics with practical work on the PC. The lecture builds on Econometrics I (regression analysis, autocorrelated and heteroscedastic disturbances) and addresses the problem of multicollinearity, the estimation of error-correction models, simultaneous equation models and the Probit model.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Practical comprehension of econometric methods and models</td>
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<tr>
<td><strong>Content</strong></td>
<td>The lecture builds on Econometrics I (regression analysis, autocorrelated and heteroscedastic disturbances) and addresses four topics: (1) the problem of Multicollinearity, (2) the concept of Stationarity and Cointegration of time series and the related estimation of Error-correction models, (3) Simultaneous equation models, (4) Probit models. Practical exercises on the PC enhance the understanding of the concepts.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Summary handouts for the lecture are available in the Teaching documents repository</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Prerequisite is Econometrics I or equivalently:</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>751-1573-00L</th>
<th>Dynamic Simulation in Agricultural and Regional Economics</th>
<th>W</th>
<th>1 credit</th>
<th>1V</th>
<th>B. Kopainsky</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Students in this class develop a dynamic simulation model that represents the basic mechanisms underlying food security in developing countries in a highly aggregated way. Students then proceed to extending the simulation model with one policy to improve food security and they analyze the dynamic impacts of this policy on production and environmental outcomes.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>- Students learn the basic theory and practice of dynamic simulation</td>
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<td></td>
<td>- Students can develop, analyze and extend a dynamic simulation model and interpret its results.</td>
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<td></td>
<td>- By applying the developed simulation model, students gain insights into food security issues. They also learn to recognize the benefits and pitfalls of dynamic simulation, both from a theoretical and an applied perspective.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>slides (will be provided during the class)</td>
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</tbody>
</table>
#### Project Management and Communication of Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-3011-00L</td>
<td>Improvement of Oral and Written Skills ■</td>
<td>W+</td>
<td>4</td>
<td>4S</td>
<td>U. Merz, E. Buff Keller, P. Mayer</td>
</tr>
</tbody>
</table>

**Abstract**
- Acquiring competence in
  - searching, analyzing and synthesizing scientific information on a specific subject
  - writing a scientific paper
  - making a scientific oral presentation, alone (with poster) and with the team
  - animating and moderating a discussion (teamwork)

**Objective**
- Acquiring competence in
  - searching, analyzing and synthesizing scientific information on a specific subject
  - writing a scientific paper
  - making a scientific oral presentation, alone (poster) and with the team
  - animating and moderating a discussion (teamwork)

**Content**
- Workshops
  - how to make a poster
  - how to present (with video-feedback)
  - how to moderate a discussion
  - scientific writing (different types of documents)
  - individual assessment:
    - make a poster and present it
    - write a review or a statement
  - team assessment:
    - write a recommendation (executive summary)
    - present the recommendation
    - moderate a discussion

**Lecture notes**
No script, but div. Instructions

**Literature**
see website

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-2062-00L</td>
<td>Research Project in FRE ■</td>
<td>W+</td>
<td>2</td>
<td>4A</td>
<td>M. Dumondel</td>
</tr>
</tbody>
</table>

**Abstract**
- Students are involved in the working out of a PhD research plan.

**Objective**
- Students are involved in the working out of a PhD research plan,

**Number of participants limited to 21.**

#### Minors

#### Agricultural- & Food- and Environmental Economics

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

**Abstract**
The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

**Objective**
- To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science.
- To analyze the evolution as well as the key elements of environmental governance.
- To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

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

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

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

**Literature**

**We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)**
This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products. The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

**Objective**

1. Knowledge of the mechanisms of agricultural trade
2. Impact of trade policy instruments on welfare and distribution
3. Specific aspects of agricultural trade and links to other courses:
   - Trade and food security
   - Trade and environment
   - Trade and development

**Content**

The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution.

By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.

**Lecture notes**

Handouts (power point presentations)

**Literature**


---

The course focuses on agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution.

By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.

**Objective**

Focus: Policy Evaluation

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

**Content**

Unit: Subject

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

**Lecture notes**

Handouts (power point presentations)

**Literature**

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


**Prerequisites / notice**

Unit 08: 1 day course at ART in Tänikon, 8356 Ettenhausen, www.art.admin.ch
Unit 09: 1 day course at FiBL in 5070 Frick, www.fibl.org

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

**Objective**

Focus: Policy Evaluation

- have a critical look at different angles of agri-economic research
- study scientific literature of the focus theme
- consider strengths, weaknesses and the application of research approaches
- apply knowledge gained from other courses with respect to the focus theme
- study scientific literature of the focus theme
- get insights in agricultural economic research of the national research institutions by visiting Agroscope Reckenholz-Tänikon ART and the Research Institute of Organic Agriculture (FiBL)
- have a critical look at different angles of agri-economic research
- consider strengths, weaknesses and the application of research approaches
- apply knowledge gained from other courses with respect to the focus theme
- study scientific literature of the focus theme

**Content**

Unit: Subject

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

**Lecture notes**

Handouts (power point presentations)

**Literature**

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


**Prerequisites / notice**

Unit 08: 1 day course at ART in Tänikon, 8356 Ettenhausen, www.art.admin.ch
Unit 09: 1 day course at FiBL in 5070 Frick, www.fibl.org
In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

**Objective**

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

**Prerequisites / notice**

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

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>751-4506-00L</td>
<td>Plant Pathology III</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>U. Merz, M. Maurhofer Bringolf</td>
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<tr>
<td></td>
<td>Information: This course was offered as &quot;Transport Systems Evaluation&quot; until FS15.</td>
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<tr>
<td>Abstract</td>
<td>Identification based on host, symptoms and micro-morphology, completed with life cycles and related control measures of the most important fungal diseases and their causal pathogens of annual and perennial crops with agricultural significance.</td>
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<tr>
<td>Objective</td>
<td>The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogen, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture.</td>
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</tr>
<tr>
<td>Content</td>
<td>A script will be used on annual and perennial crops and their most important diseases. It will be updated stepwise</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.</td>
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<tr>
<td>Literature</td>
<td>See <a href="http://www.ib.ethz.ch">www.ib.ethz.ch</a> (teaching, materials)</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-4805-00L</td>
<td>Recent Advances in Biocommunication</td>
<td>W+</td>
<td>2</td>
<td>2S</td>
<td>C. De Moraes</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 25</td>
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<tr>
<td>Abstract</td>
<td>Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.</td>
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<tr>
<td>Objective</td>
<td>Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.</td>
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<tr>
<td>Lecture notes</td>
<td>Provided to students through IIIAS</td>
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<tr>
<td>Literature</td>
<td>Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information.</td>
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</table>
The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of isotopes into a system can be done so as to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students.

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

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

Lecture notes
Documents will be distributed during the lecture

Literature
Will be given during the lecture

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

Environmental Crop Physiology

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-3405-00L</td>
<td>Radio-Isotopes in Plant Nutrition</td>
<td>W+</td>
<td>3</td>
<td>2</td>
<td>E. Frossard</td>
</tr>
<tr>
<td>751-4003-01L</td>
<td>Current Topics in Grassland Sciences (HS)</td>
<td>W+</td>
<td>2</td>
<td>2</td>
<td>N. Buchmann</td>
</tr>
<tr>
<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W</td>
<td>2</td>
<td>2</td>
<td>A. Walter, B. Büter</td>
</tr>
</tbody>
</table>

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

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

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

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

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

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

**751-4203-00L Horticultural Science: Case Studies (HS)**

**W** 2 credits  **G** 2L  **Bertschinger, J. Rösti, V. J. U. Zufferey**

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

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

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

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

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

**Prerequisites / notice**
As provided by the case study leaders.

**751-5101-00L Biogeochemistry and Sustainable Management**

**W+** 2 credits  **G** 2L  **Morbach, N. Buchmann**

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

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

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

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

**Literature**
Will be discussed in class.

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

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

**W+** 2 credits **IS** 1L  **Frossard, E.**

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

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

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

**W+** 4 credits  **G** 4L  **Gamper, H. A. Gampfer, E. K. Bünemann König, T. I. McLaren**

**Abstract**
This course emphasizes interactions among physicochemical and biological processes and highlights implications for plant nutrition, growth, and health. Nutrient mobilization and acquisition by plants in response to fertilization, other plants, and microbes, are explored in model systems. Newly gained knowledge is applied to understand results of a pot experiment and thereby critically reflected.

**Objective**
To gain a holistic understanding of resource-driven and regulatory processes in natural and agronomic plant-microbe-soil systems. To practice abilities to read scientific literature, understand it, present it, and discuss it with peers. To combine available and newly acquired knowledge from soil physics, chemistry and (micro-)biology, plant physiology, pathology, and ecology and reflect on their relative importance for plant production, bioremediation, and nature conservation when considered together. To practice manual skills in handling seedlings, soil, plant, and DNA samples, laboratory equipment, and working with different computer software. To make observations, analyze, display, interpret and present own data. To get familiar with (bio-)chemical, molecular genetic, and simple bioinformatics analyses. To prepare as a group of course participants a poster on one selected aspect of a bigger pot experiment, present it, and discuss findings and posters of other course participants. To combine findings with available knowledge, generate explanatory hypotheses, and identify potentially informative further analyses and experiments.

**Content**
This course comprised lectures, the set-up, harvest and data analysis of an experiment, soil (bio-)chemical, microbiological and molecular genetic analyses in the laboratory and practical computational data analyses. The focus is set on a better understanding of the role played by spatial and temporal physicochemical and microbiological gradients and various soil organisms in plant mineral nutrition. Mutualistic associations between plant roots and microbes, such as the root symbiosis with mycorrhizal fungi and root nodule-inducing bacteria are discussed. Rhizobia are isolated from field-collected root nodules and characterized, using molecular genetic tools. A short introduction into DNA-based bioinformatics and phylogenetic analyses is given to demonstrate how bacterial species are identified and potential host ranges of isolated rhizobia can be inferred, using so-called functional genes. A pot experiment in the glasshouse on cereal-legume mixed intercropping, including effects of pot size, intra- and interspecific plant competition, and root traits, allows to relate scientifically interesting research topics to practical application, while simultaneously stimulating critical reflections.

**Language:** spoken E, G or F. Documents: Preferably English, G/F possible.
Lecture slides and laboratory protocols are being made available in the directory '751-5123-00L Rhizosphere Ecology' of the electronic document exchange platform ILIAS, LDA-ELBA:

Arbuscular mycorrhizas in soil nutrient management, e-learning module of Sustainable Plant Systems by Gamper, HA, van der Heijden, MGA, Hofmann, A.: https://www.olat.uzh.ch/olat/auth/1%3A1%3A0%3A0%

http://www.els.net/WileyCDA/ElArticle?id=a0000430.html

http://www.sciencedirect.com/article/pii/S0038071715000449

Prerequisites / notice
For students of the Agricultural Sciences of D-USYS: Lectures in Plant Nutrition I and II (Nutrient cycling in agroecosystems by Prof. E. Frossard).
We ask all other course participants to read and understand the e-learning module Plant Nutrition I by Prof. E. Frossard:
https://moodle-app2.let.ethz.ch/course/view.php?id=792

We ask all other course participants to read and understand the e-learning module of Sustainable Plant Systems by Gamper, HA, van der Heijden, MGA, Hofmann, A.: https://www.olat.uzh.ch/olat/auth/1%3A1%3A0%3A0%

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

For the students of the Agricultural Sciences of D-USYS: Lectures in Plant Nutrition I and II (Nutrient cycling in agroecosystems by Prof. E. Frossard).

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

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

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

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

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

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

751-3603-00L Plant Breeding II

Abstract
The course consists of two parts. First, important plant breeding concepts such as, molecular breeding and genetic engineering but also organic and participatory breeding are introduced and discussed. Furthermore, we look at the legislation affecting these concepts. Second, the application of different plant breeding methodologies and their effect on the evolution of major crops are highlighted.

Content
In the first part of the course, we will discuss most important plant breeding tools and concepts. The lectures include lessons on genetic engineering utilizing genetic variation across species; organic plant breeding focussing on the need of organic agriculture; participatory plant breeding involving farmers in the breeding progress as well as genomic selection using a genome-wide coverage of molecular markers to predict the performance of a genotype. You will learn how new marker technologies and breeding tools in combination with precise phenotyping may influence the breeding progress in the future and how knowledge of the genetic architecture of crops can be utilized for selection. Furthermore, we will cover the legislation around the conservation of crop genetic resources for food and agriculture (PGRFA), the plant breeding rights (UPOV), gene patenting and the release of genetically modified organisms into the environment.

Differences in legislation on worldwide scale, in Europe and in Switzerland will be highlighted. At the end of this section, you will be able to critically discuss the pros and cons of different concepts of plant breeding ranging from organic and participatory breeding to genetic modification and gene patenting.

In the second part of the course, you will learn most important aspect of crop evolution and breeding of maize, wheat, rapeseed, sugar beet, potatoes and forage crops. This includes: the most important domestication traits; crop evolution; genetics and cytogenetic; reproductive biology, germplasm resources; major breeding aims and common breeding methods. At the end of this section you will be able to discuss the most important achievement of our major crops in a plant breeding context.

Prerequisites / notice
The participation in this course requires a basic understanding of plant breeding as taught in ‘Pflanzenzüchtung 1’ (formerly Pflanzenzüchtung), or similar lectures at other universities.
Content

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

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

Lecture notes

Handouts will be available on the webpage of the course.

Prerequisites / notice

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

751-5115-00L

Current Aspects of Nutrient Cycle in Agro-Ecosystems

W+ 2 credits 1S E. Frossard

Abstract

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

Objective

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

751-5001-00L

Agroecologists without Borders

W 2 credits 2S C. Decock, A. Hofmann, J. Six

Abstract

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

Objective

(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems.

(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.

(3) Students articulate complexity and challenges in agricultural development interventions.

(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.

Prerequisites / notice

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

Non-Ruminant Science

Number Title Type ECTS Hours Lecturers

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

Abstract

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

Objective

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

Content

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

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

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

Lecture notes

No scriptum

Prerequisites / notice

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

751-6305-00L Livestock Breeding and Genomics I W 2 credits 1V B. Gredler, P. von Rohr

Abstract

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

Objective

The students are able to estimate breeding values for the most common population structures using the selection index. They are able to set up design matrices, the relationship matrix and its inverse as well as the Mixed Model equations to estimate BLUP breeding values for smaller examples.

Content

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

Lecture notes

Copies of the slides are available on the net.

Literature

To be announced in the lectures.

751-6601-00L Pig Science (HS) W 3 credits 3V E. Hillmann, M. C. Härdi-Landerer
The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration

Farm animals play an important role in most agro/eco - systems, but conditions for a successful management and nutrition in the tropics

Specific literature is indicated by the lecturers.

The course provides methods to use molecular genetics information in livestock breeding. First, linkage disequilibrium, its measurement and applications are introduced. Genomic selection, genome wide association studies, and estimation of breeding values are further topics. The theory is applied in assignments.

The students are able to interpret and apply linkage disequilibrium. They are able to discuss the principles of genomic selection, genome wide association studies and breeding value estimation.

Copies of the slides are available on the net.

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

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

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

The theory is applied in assignments.

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

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

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

Ruminant Science

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

In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.
Methods for analysing livestock data, in particular for the estimation of breeding values: principles of selection index, correction of records

M. Kreuzer

To be announced in the lectures.

B. Gredler, M. C. Härdi-Landerer, W+

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

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

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

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

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

no scriptum

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

Lecture notes

Prerequisites / notice

751-6305-00L Livestock Breeding and Genomics I W 2 credits 1V B. Gredler, P. von Rohr

Abstract

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

Objective

The students are able to estimate breeding values for the most common population structures using the selection index. They are able to set up design matrices, the relationship matrix and its inverse as well as the Mixed Model equations to estimate BLUP breeding values for smaller examples.

Content

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

Lecture notes

Copies of the slides are available on the net.

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

Abstract

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

Objective

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

Content

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

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

Lecture notes

Documentation links and other materials will be provided at the start of the course.

Literature

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

Prerequisites / notice

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

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

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

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

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

Abstract

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

Objective

The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal feeding diets using highly fibrous forages and a variety of other feeds. The students also are able to show how to modify the most important rumen microbes beneficially by nutritional means.
The course provides methods to use molecular genetics information in livestock breeding. First, linkage disequilibrium, its measurement and applications are introduced. Genomic selection, genome wide association studies, and estimation of breeding values are further topics. The theory is applied in assignments.

The students are able to interpret and apply linkage disequilibrium. They are able to discuss the principles of genomic selection, genome wide association studies and breeding value estimation.

The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include:

- Demand for food
- Matching demand with supply
- Industrial organization in the food supply chain
- Non-quality attributes of food
- Food production and the environment
- The food sector within human economies
- Food production and the environment
- When information is costly
- Microeconomics.

Safety and Quality in Agri-Food Chain

The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include:

- Food Economics
- Genomewide association studies
- Genomic selection and estimation of breeding values
- Genomewide association studies
- Assignments

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

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

Literature
To be announced in the lectures.

Prerequisites / notice

751-7603-00L Livestock Breeding and Genomics II W 1 credit 1V B. Gredler, P. von Rohr

Abstract
The course provides methods to use molecular genetics information in livestock breeding. First, linkage disequilibrium, its measurement and applications are introduced. Genomic selection, genome wide association studies, and estimation of breeding values are further topics. The theory is applied in assignments.

Objective
The students are able to interpret and apply linkage disequilibrium. They are able to discuss the principles of genomic selection, genome wide association studies and breeding value estimation.

Content
- Linkage disequilibrium
- Genomic selection and estimation of breeding values
- Genomewide association studies
- Assignments

751-7703-00L Tropical Animal Nutrition W 1 credit 1G

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

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

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

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

Abstract
Endocrinologie und Reproduktionsbiologie der Säugetiere und des Menschen (Anatomie, Morphologie, Physiologie, Regelmechanismen)

Die Systematik der Reproduktionshormone und der Hormonrezeptoren wird erläutert, die Wirkungsmechanismen (Bildung; orale Bioverfügbarkeit; Elimination) erklärt. Mit diesen Grundlagen wird das Verständnis der Regulation der Fortpflanzung umfassend erörtert.

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

Safety and Quality in Agri-Food Chain

The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include:

- Food Economics
- Genomewide association studies
- Genomic selection and estimation of breeding values
- Genomewide association studies
- Assignments

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

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

Literature
To be announced in the lectures.

Prerequisites / notice

751-1555-00L Food Economics W+ 2 credits 2G A. Champetier de Ribes

Abstract
Food Economics proposes to explore important issues in food production, supply, and consumption using the concepts and tools of microeconomics.

Objective
The two objectives of the class are:
- to provide an overview of the important issues related to food markets and supply chains
- to present the economics concepts and tools that are useful to understand the functioning of food supply chains under various governance regimes or policies (emphasis on welfare analysis)

Content
The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include:

- Demand for food
- Matching demand with supply
- Industrial organization in the food supply chain
- Non-quality attributes of food
- Food production and the environment
- The food sector within human economies

In addition, the students collectively identify and address an applied research question. We implement an empirical strategy to tackle the question before results are discussed individually by students during the final written examination.

Lecture notes
Lecture notes are made available after each lecture.
The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

**752-2122-00L Food and Consumer Behaviour**

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

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

**Prerequisites / notice**
Students are expected to master basic microeconomics concepts such as demand, supply, or consumer and producer surplus. We will review how to calculate elasticities, tax and quota impacts on prices etc...but the class focuses on applications of these tools rather than on basic understanding. Students are expected to have taken at least one intermediary microeconomics class.

**752-2307-00L Nutritional Aspects of Food Composition and Processing**

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

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

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

**Prerequisites / notice**
The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.

**751-2401-00L Food and Agricultural Trade Policy**

**Abstract**
The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution. By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.

**Objective**
Objectives

1. Knowledge of the mechanisms of agricultural trade
2. Impact of trade policy instruments on welfare and distribution
3. Specific aspects of agricultural trade and links to other courses:
   - Trade and food security
   - Trade and environment
   - Trade and development

**Content**
The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution. By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.

**751-4203-00L Horticultural Science: Case Studies (HS)**

**Abstract**
Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treating on one of the cropping systems treating. In a final colloquium, each group presents a report on their case study and their conclusions.

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

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

**751-6001-00L Forum: Livestock in the World Food System**

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

**Objective**
In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.
Content
The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:

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

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

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

Lecture notes
no scriptum

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

752-5111-00L Gene Technology in Foods

W 3 credits 2V L. Meile

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

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

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

Lecture notes
Copies of slides from lectures will be provided

Literature
Actual publications from literature will be provided

Prerequisites / notice
Good knowledge in biology, especially in microbiology and molecular biology are prerequisites.

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

751-0021-00L World Food System Summer School

W 4 credits 6P M. Grant, N. Buchmann

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

Objective
World food system overview; agricultural production; Global change drivers; retail; Nutrition and health; National policy and state interventions. The course will conclude with a group work on food system challenges.

Content
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Lecture notes
Individually prepared presentations of the group leaders

Literature
No prerequisites. Program is open to Masters, PhD and upper level Bachelor students.

Functioning of Soil Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0533-00L</td>
<td>Soil Chemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Kretzschmar, D. I. Christl</td>
</tr>
</tbody>
</table>

Abstract
This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

Objective
Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.

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

Lecture notes
Handouts in lectures.

Literature

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology

W 3 credits 2G+2U D. Or

Abstract
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems. Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the complex interactions of a coupled human-environmental system.

This course focuses on the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course. Global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the complex interactions of a coupled human-environmental system.

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

Biogeochemistry and Sustainable Management

L. Merbold

2 credits

Current Aspects of Nutrient Cycle in Agro-Ecosystems

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

Objective

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

751-5123-00L Rhizosphere Ecology

W+ 4 credits 4G

H. A. Gamper

E. K. Bünnemann König.
Abstract This course emphasizes interactions among physicochemical and biological processes and highlights implications for plant nutrition, growth, and health. Nutrient mobilization and acquisition by plants in response to fertilization, other plants, and microbes, are explored in model systems. Newly gained knowledge is applied to understand results of a pot experiment and thereby critically reflected.

Objective To gain a holistic understanding of resource-driven and regulatory processes in natural and agronomic plant-microbe-soil systems. To practice abilities to read scientific literature, understand it, present it, and discuss it with peers. To combine available and newly acquired knowledge from soil physics, chemistry and (micro)-biology, plant physiology, pathology, and ecology and reflect on their relative importance for plant production, bioremediation, and nature conservation when considered together. To practice manual skills in handling seedlings, soil, plant, and DNA samples, laboratory equipment, and working with different computer software. To make observations, analyse, display, interpret and present own data. To get familiar with (bio-)chemical, molecular genetic, and simple bioinformatics analyses. To prepare as a group of course participants a poster on one selected aspect of a bigger pot experiment, present it, and discuss findings and posters of other course participants. To combine findings with available knowledge, generate explanatory hypotheses, and identify potentially informative further analyses and experiments.

Content This course comprised lectures, the set-up, harvest and data analysis of an experiment, soil (bio-)chemical, microbiological and molecular genetic analyses in the laboratory and practical computational data analyses. The focus is set on a better understanding of the role played by spatial and temporal physicochemical and microbiological gradients and various soil organisms in plant mineral nutrition. Mutualistic associations between plant roots and microbes, such as the root symbiosis with mycorrhizal fungi and root nodule-inducing bacteria are discussed. Rhizobia are isolated from field-collected root nodules and characterized, using molecular genetic tools. A short introduction into DNA-based bioinformatics and phylogenetic analyses is given to demonstrate how bacterial species are identified and potential host ranges of isolated rhizobia can be inferred, using so-called functional genes. A pot experiment in the glasshouse on cereal-legume mixed intercropping, including effects of pot size, intra- and interspecific plant competition, and root traits, allows to relate scientifically interesting research topics to practical application, while simultaneously stimulating critical reflections.

Lecture notes Lecture slides and laboratory protocols are being made available in the directory ‘751-5123-00L Rhizosphere Ecology’ of the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=85894&cmdClass=ilrepositorygui&cmdNode=el&baseClass=ilRepositoryGUI
This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to
arbuscular mycorrhizas in soil nutrient management, e-learning module of Sustainable Plant Systems by Gamper, HA, van der Heijden, MGA, Hofmann, A.: https://www.olat.uzh.ch/olat/auth/1%3A1%3A0%3A0%3A0/
DOI: 10.1002/9780470015902.a0000403.pub2
http://www.els.net/WileyCDA/ElsArticle refId=a0000403.html
http://www.nature.com/scitable/knowledge/plant-plant-soil-interactions-nutrient-uptake-105289112
http://www.crcpress.com/product/isbn/9780849338557
Plant Soil 321, 117-152.
http://link.springer.com/article/10.1007%2Fs11104-008-9885-9
http://dx.doi.org/10.1111/nph.12235
http://www.plantphysiol.org/content/156/3/1078
Withers PJA, Sylvester-Bradley R, Jones DL, Healey JR, Talboys PJ. 2014. Feed the crop not the soil: rethinking phosphorus management
in the food chain. Environmental Science & Technology: http://dx.doi.org/10.1021/es501670j
How microbes can feed the world (American Academy of Microbiology)
http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world
Can microbes feed the world? (Society for general microbiology)
Popular science entries to the topic:
http://www.the-scientist.com/?articles.view/articleNo/30950/title/The-Root-of-the-Problem/
Ecological Understanding (Second Edition)
The Nature of Theory and the Theory of Nature:
Prerequisites / notice
For students of the Agricultural Sciences of D-USYS: Lectures in Plant Nutrition I and II (Nutrient cycling in agroecosystems by Prof. E. Frossard).
We ask all other course participants to read and understand the e-learning module Plant Nutrition I by Prof. E. Frossard:
https://moodle-app2.let.ethz.ch/course/view.php?id=279
For students of the Agricultural Sciences of D-USYS: Lectures in Plant Nutrition I and II (Nutrient cycling in agroecosystems by Prof. E. Frossard).
We ask all other course participants to read and understand the e-learning module Plant Nutrition I by Prof. E. Frossard:
https://moodle-app2.let.ethz.ch/course/view.php?id=279
A written closed book exam will take place on Friday January 8, 2016, from 10.15-12.15am in Eschikon.
Maximum number of participants: 18.
Students of the agricultural sciences of D-USYS will be reimbursed for travel expenses upon handgun collection of tickets of the public
transport systems, excluding the tax zone of the town of Zurich.
751-5125-00L Stable Isotope Ecology of Terrestrial Ecosystems W+ 2 credits 2G
R. A. Werner, N. Buchmann, R. Siegwolf
Abstract
This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to
process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of
composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions.
Objective
Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know
the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to
solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze
literature as well as to give an oral presentation.
Content

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

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

Lecture notes

Handouts will be available on the webpage of the course.

Literature

Will be discussed in class.

Prerequisites / notice

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

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<tr>
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<tbody>
<tr>
<td>751-5001-00L</td>
<td>Agroecologists without Borders</td>
<td>W 2 credits</td>
<td>2S</td>
<td>C. Decock, A. Hofmann, J. Six</td>
<td></td>
</tr>
<tr>
<td>751-5201-00L</td>
<td>Tropical Soils and Land Use</td>
<td>W 2 credits</td>
<td>2G</td>
<td>J. Six</td>
<td></td>
</tr>
<tr>
<td>751-3405-00L</td>
<td>Radio-Isotopes in Plant Nutrition</td>
<td>W 3 credits</td>
<td>2G</td>
<td>E. Frossard</td>
<td></td>
</tr>
</tbody>
</table>

Objective

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

Prerequisites / notice

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

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<tr>
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<tbody>
<tr>
<td>751-1030-00L</td>
<td>Master’s Thesis</td>
<td>O 30 credits</td>
<td>64D</td>
<td>Lecturers</td>
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</tr>
<tr>
<td>760-0001-00L</td>
<td>Colloquium Master in Agricultural Science</td>
<td>E- 0 credits</td>
<td>2K</td>
<td>Lecturers</td>
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</tr>
<tr>
<td>751-0023-00L</td>
<td>ETH Week 2015: The Story of Food</td>
<td>W 1 credit</td>
<td>3S</td>
<td>S. Brusoni, K. Fenner, A. Walter, C. Bratrich, N. Buchmann, A. Champetier de Ribes, M. Grant, W. Langhans</td>
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</table>

Master Thesis

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

The Master thesis is an independent scientific work. Normally the subject is selected among the topics of the core subject. It is written under the guidance of an agricultural science professor.

The independent writing of a scientific paper/thesis

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Complementary Courses

The ETH Week is a new and innovative course designed to foster critical and independent thinking and creative learning. Students from all departments as well as professors and external experts will work together for one week in interdisciplinary teams. They will develop ideas and interventions that could play a role in solving some of our most pressing global challenges: the global food systems.
Objective
- Domain-specific knowledge: Students have immersed knowledge about a certain complex, societal topic which will be selected every year. They understand the complex system context of the current topic, by comprehending its scientific, technical, political, social, ecological and economic perspectives. The focus in 2015 is the global food system.

- Analytical skills: The ETH Week participants are able to structure complex problems using selected methods. With the help of experts and team tutors, they are able to acquire further knowledge and critically analyse knowledge in interdisciplinary groups.

- Design skills: The students are able to use problem solving and decision making skills to develop concrete approaches for addressing a selected problem statement, critically reflect these approaches, assess their feasibility, transfer them into a concrete form (physical model, prototypes, strategy paper, etc.) and to present this work in a creative way (role-plays, videos, exhibitions, etc.).

- Self-competence: The students are able to plan their work effectively, efficiently and autonomously. By considering approaches from different disciplines they are able to make a judgment and form a personal opinion. They are able to communicate appropriately with non-academic partners from business, politics, administration, non-governmental organizations and media, present their results professionally and creatively and convince a critical audience.

- Social competence: The students are able to work in multidisciplinary teams, i.e. they can reflect critically their own discipline, debate with students from other disciplines and experts in a critical-constructive and respectful way and can relate their own positions to different intellectual approaches. They can assess how far they are able to actively make a contribution to society by using their personal and professional talents and skills and as ‘Change Agents’.

Content
The week puts a focus on developing problem solving and design thinking skills within the context of understanding the world of food. During ETH Week students will have the opportunity to work in small interdisciplinary groups, allowing them to critically analyse both their own approaches and those of other disciplines, and to integrate these into their work.

While deepening their knowledge about how the food system works, students will be introduced to various methods and tools for generating creative ideas and understand how different people are affected by each part of the system. In addition to lectures and literature, students will acquire knowledge via excursions into the real world, empirical observations, and conversations with researchers and experts.

A key attribute of the ETH Week is that students are expected to find their own problem, rather than solve the problem that has been pre-defined. Therefore, teams will spend the first three days of the week identifying a problem to work on, and the last two days of the week generating solutions for the problem and communicating the team’s ideas.

A panel of experts will judge your presentations at the end of the week. The winning teams will receive attractive prizes.

Literature
Participants will receive preparation reading materials before the course commences.

Prerequisites / notice
No prerequisites. Program is open to Bachelor and Masters from all ETH Departments. Students must register to attend the course by 17 May at www.ethz.ch/ETHWeek.

Agroecosystem Science Master - Key for Type

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

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Applied Geophysics Master

Courses at ETH Zurich only take place in Spring Semester.

<table>
<thead>
<tr>
<th>Key for Type</th>
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<tbody>
<tr>
<td>O</td>
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<td>W+</td>
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<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
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<tr>
<td>Dr</td>
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</table>

Key for Hours

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<th>Type</th>
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<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS: European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>051-011I-00L</td>
<td>Architecture I</td>
<td>O</td>
<td>1</td>
<td>2</td>
<td>C. Kerez</td>
</tr>
<tr>
<td>Abstract</td>
<td>In a series of lectures aspects of the architectonical space will be exemplified and put into a theoretical context.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Training of a conscious perception and a conceptual understanding of the architectural space as well as techniques for its representation.</td>
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<tr>
<td>051-015I-00L</td>
<td>Architectural Technology I</td>
<td>O</td>
<td>1</td>
<td>2</td>
<td>A. Spiro, D. Fiederling</td>
</tr>
<tr>
<td>Objective</td>
<td>Knowledge of construction principles and its history. Cognition of correlation between concept, buildings structure, material and form.</td>
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</tr>
<tr>
<td>Content</td>
<td>In the triad of typology, topology and tectonics, the latter is the primary focus of the theoretical discourse. The series of lectures identifies the most disparate tectonic principles which transcend time and geography, and elucidates the reciprocally generative parameters of construction, technology and form. The lectures themes convey fundamental concrete constructional and practical knowledge and concentrate on the guidance of the basic exercises (Architectural Technology I + II).</td>
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<tr>
<td>051-021I-00L</td>
<td>Architecture and Art I</td>
<td>O</td>
<td>1</td>
<td>2</td>
<td>K. Sander</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and practice in the visual arts: Artistic thinking and practice.</td>
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<tr>
<td>Objective</td>
<td>Independent artistic thinking. Acquisition of artistic criteria.</td>
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<tr>
<td>Content</td>
<td>Reflection of visual contents and phenomena. Examination of current positions in art.</td>
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</table>

### Examination Block 2

<table>
<thead>
<tr>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>051-041I-00L</td>
<td>Structural Design I</td>
<td>O</td>
<td>4</td>
<td>4G</td>
<td>P. Block, J. Schwartz</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course is an introduction to structural design using graphical methods and structural models, with a focus on a creative approach rather than repetitive calculations. Cable and membrane structures, arch and shell structures and combined arch and cable systems will be used to demonstrate these methods.</td>
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<tr>
<td>Content</td>
<td>After a general introduction of basic concepts, structural systems such as cable and arch structures will be analyzed with the help of graphic statics. The students will learn to understand the flow of forces in a structural system in relation to the system’s form. They will be able to modify this force flow and give dimension to the structural components.</td>
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<tr>
<td>Lecture notes</td>
<td>All concepts, approaches and methods will be introduced in the weekly lectures and practiced in subsequent exercises.</td>
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<tr>
<td>Literature</td>
<td>on eQuilibrium</td>
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<td></td>
<td><a href="http://www.block.arch.ethz.ch/equilibrium">http://www.block.arch.ethz.ch/equilibrium</a></td>
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<td>and</td>
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<td><a href="http://www.schwartz.arch.ethz.ch/">http://www.schwartz.arch.ethz.ch/</a></td>
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<td></td>
<td>“Faustformel Tragwerksentwurf”</td>
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<td></td>
<td>(Philipp Block, Christoph Gengangel, Stefan Peters, DVA Deutsche Verlags-Anstalt 2013, ISBN: 978-3-421-03904-0)</td>
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<td></td>
<td>Weiteres Lernmaterial:</td>
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<td></td>
<td>“Form and Forces: Designing Efficient, Expressive Structures”</td>
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<tr>
<td>051-085I-00L</td>
<td>Building Materials I</td>
<td>O</td>
<td>2</td>
<td>2</td>
<td>F. Winnefeld, M. Koebel, O. von Trzebiatowski, T. A. Zimmermann Schütz</td>
</tr>
<tr>
<td>Abstract</td>
<td>Building Materials - Structure, Quality, Usage</td>
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<tr>
<td></td>
<td>concrete and other mineral materials</td>
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<td></td>
<td>metals, wood, glass and polymers</td>
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<td></td>
<td>ecological aspects</td>
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<tr>
<td>Objective</td>
<td>The lecture describes the fundamental properties of the most important construction materials: concrete and other mineral materials, metals, wood, glass and polymers. Furthermore, the content includes the relevant ecological aspects such as availability of raw materials, effort for production, emission of hazardous substances, disposal and recycling are treated as well.</td>
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<tr>
<td>051-088I-00L</td>
<td>Sociology I</td>
<td>O</td>
<td>1</td>
<td>2</td>
<td>C. Schmid</td>
</tr>
<tr>
<td>Abstract</td>
<td>Sociology I investigates the relation between social developments and the production of the built environment from a macro-sociological point of view. It examines central aspects of social change, historical and present-day forms of urbanization, and typical examples of models of urbanization.</td>
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<tr>
<td>Objective</td>
<td>This series of lectures should enable students to comprehend architecture in its social context. It approaches the architectural profession from two different angles: macro-sociological and micro-sociological.</td>
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<tr>
<td>Content</td>
<td>Sociology I deals with the macro-sociological point of view, and investigates the relation between social developments and the production of the built environment. In the first part some central aspects of social change are examined in particular the transition from Fordism to Postfordism and from Modernism to Postmodernism, and the interlinked processes of globalization and regionalization. The second part deals with historical and present-day forms of urbanization. Among other aspects treated here are the changed significance of urban-rural contrasts, the processes of suburbanization and periurbanization, the formation of global cities and metropolitan regions, the growth of new urban configurations in centres (gentrification) and on urban peripheries (edge city, exopolis). In the third part these general processes are illustrated by typical models of urbanization.</td>
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</table>
Introduction to economics and to the analysis of markets.

The lecture conveys historical knowledge about architecture and art as well as methodical knowledge as a preparation for the independent handling of historical sources and scientific literature. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

Objective
Acquisition of basic knowledge of the history of art and architecture, resp. of methodical basic knowledge of historical working.

Content
The history of art and architecture is part of our reality: it confronts us in the historically shaped environment of the city and plays an essential role in the creation of architecture. The historical lectures are therefore part of the fundamental courses of the undergraduate programme in architecture. On the basis of cultural and art-historical research this course impart knowledge about architecture and art from ancient times to the present. At the same time they sharpen the perception for the conditions and capabilities of building activity in history. Moreover, they convey methodical knowledge and technical language skills and are meant as a preparation for the independent handling of historical sources and scientific literature.

The first one-year course aims at these goals at these goals in the form of exemplary epoch representations which through light upon the historical continuities. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

Lecture notes
3 Skripte sind auf der Professur, HIL C 70-5-8, erhältlich:
- Architektur der Klassischen Antike, Fr. 15.-
- Renaissance und Barock, Fr. 15.-
- Aufklärung bis Moderne, Fr. 15.-

Prerequisites / notice
Zu beziehen am Dienstag und Donnerstag

The course can not be taken by Master students of the D-ARCH, who have already completed it within the Bachelor programme.

Economics I

Prerequisites / notice
051-0331-00L

051-0823-00L

Economics I

Introduction to economics and to the analysis of markets.

Objective
Understanding of the basic economic concepts and models and of their application to real world situations, notably on property markets.

Content
The course in economics extends over two semesters. The focus during the Fall term is on an introduction to economic thought. These considerations provide the fundamental requirements for the economic analysis of land, housing and urban markets in the following Spring term.

The Fall semester focuses on the economic way of thinking. We shall discover why A. Marshall defined economics as "a study of mankind in the ordinary business of life". The course introduces the student to the "big questions" in economics, such as the concept of rationality and its limits, factors driving supply and demand, the working of markets, the importance of the price system and the reasons why markets may fail.

There are many interactions between economic and social phenomena on the one hand, and the built environment on the other. Our knowledge of the fundamental economic principles will allow us to understand the workings of the housing, land, credit and real estate markets - markets of fundamental importance for the future architect. We consider questions such as: which are the major problems of the land market? Which factors determine the price of land? What are the economic drivers that shape the form of our cities? Which are the primary difficulties in designing a reasonable housing policy? Finally, the course discusses the main determinants of real estate investment, both its risk and its opportunities.

Lecture notes
Course material in e-learning environment www.vwl.ethz.ch/architektur

Literature

Prerequisites / notice
Zu beziehen am Dienstag und Donnerstag

0401-0001-00L

Mathematics I

Abstract
Description and discussion of curves and surfaces focusing on their generation by movement: Parameterization, tangent vector, tangent plane, ruled surfaces, developable surfaces. (Methods of vector geometry and differential calculus are used.)

Objective
Vertiefen und Ergänzen der mathematischen Kenntnisse und Fertigkeiten

Content
Erkennen, dass mathematische Beschreibung und Abstraktion zu neuen Einsichten führen und verborgene Zusammenhänge erschliessen können.

Lecture notes
script available (in german)

Prerequisites / notice

Subjects with Semester Grade

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>051-0211-02L</td>
<td>Architecture and Art I (2-Semester Course, Exercise)</td>
<td>O</td>
<td>0</td>
<td>6U</td>
<td>K. Sander</td>
</tr>
<tr>
<td>051-0129-00L</td>
<td>Architectural Design I (2-Semester Course, Exercise)</td>
<td>O</td>
<td>0</td>
<td>6U</td>
<td>C. Kerez</td>
</tr>
<tr>
<td>051-0130-00L</td>
<td>Architectural Technology I (2-Semester Course, Exercise)</td>
<td>O</td>
<td>0</td>
<td>6U</td>
<td>A. Spiro</td>
</tr>
</tbody>
</table>
Exercise

Empirical and analytical acquirement of basic construction principles. In a series of creatively designed exercises, various terms related to the subject area of Material - Structure - Space are made sensually tangible and are dealt with conceptually. Their interdependence will become apparent in the process and the relationship between tectonics and visual expression will be studied.

In addition, the influence of materials and their properties, of construction principles and their specific application as well as of planning and production processes on the form as the end result will be elaborated theoretically in a series of lectures.

► Second and Third Year Basic Courses

►► Examination Blocks

►►► Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>051-0113-00L</td>
<td>Architecture III</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>D. Eberle</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lectures discuss determining factors in architectural design based on the basic terms place, structure, shell, program and materiality.</td>
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<tr>
<td>Objective</td>
<td>The lectures aim at conveying an integral understanding of architecture: its development, its determining factors, and the influence of its societal context.</td>
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<tr>
<td>Content</td>
<td>The lectures discuss significant determining factors in architectural design based on five basic terms place, structure, shell, program and materiality. Several architectural examples are being examined within their specific societal context with an emphasis on the interrelation of architecture, science, culture and art.</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Architectural Technology III</th>
<th>O</th>
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<th>2V</th>
<th>A. Deplazes</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>Addresses construction as integrating component of design processes, including considerations based on contemporary case studies. Elaboration of construction principles on the basis of solid and filigree structure theories.</td>
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<tr>
<td>Objective</td>
<td>Addresses construction as integrating component of design processes, including considerations based on contemporary case studies.</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Urban Design I</th>
<th>O</th>
<th>1 credit</th>
<th>2V</th>
<th>H. Klumppner, A. Brillembourg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The lecture series will introduce tools for reading contemporary urban conditions, urban models and operational modes. Urban development will be deciphered, presented as operational tools, extracted from cities where they have been tested and became exemplary samples, most relevant for providing the understanding of how urban landscape has taken shape as well as inspiration for future practice.</td>
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<tr>
<td>Objective</td>
<td>How can a glossary of tools be used as a basis for reading cities and recognizing in them current trends and urban phenomena? The lectures series will produce a glossary of operational urban tools with collected urban knowledge that provides students with an ‘improved’ manual to navigate theories. Urban Stories is a lecture series that aims to amplify your repertoire of urban instruments and empowers you to read cities and to critically reflect on the urban environment. The course will approach a series of case studies, employing an analytical, research-based model for crosscutting scale, political, economical and social components. Through this lens, and with our toolbox, we aim to tell the fundamental story of our cities from today and provide information, analysis and knowledge to help students prepare for justifiable own contributions and interventions in the future. Also the aspect of knowledge transfer will be considered in order to sensibilize the students to understand how to operate in an international context.</td>
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<tr>
<td>Content</td>
<td>How did cities develop into the cities we live in now? Which urban plans, instruments, visions, political decisions, economic reasonings, cultural inputs and social organization have been used to operate in urban settlements in specific moments of change? Which cities are exemplary in illustrating how these instruments have been implemented and how they have shaped urban environments? Can these instruments be transcribed into urban operational tools that we recognize within existing tested cases in contemporary cities across the globe? Urban form cannot be reduced to the physical space. Cities are the result of social construction, under the influence of technologies, ecology, culture, the impact of experts and accidents. Urban unconsidered processes respond to political interests, economic pressure, urban inclinations, along with the imagining of architects and planners and the informal powers at work in complex adaptive systems. Current urban phenomena are the result of an urban evolution. The facts stored in urban environments include contributions from its entire lifecycle. That is true for the physical environment, but also for non-physical aspects, the imaginary city that exists along with its potentials and problems and with the conflicts that have evolved over time. Knowledge and understanding along with a critical observation of the actions and policies are necessary to understand the diversity and instability present in the contemporary city and to understand how urban form evolved to its current state. This lecture series will introduce urban knowledge and the way it has introduced urban models and operational modes within different concrete realities, therefore shaping cities. Urban knowledge will be translated into operational tools, extracted from cities where they have been tested and become exemplary samples, most relevant for providing the understanding of how urban landscape has taken shape. Case studies will be identified to compile documents and an archive, that we use as templates to read the city and to critically reflect upon it. The presented contents are meant to serve as inspiration for positioning in future professional life as well as to provide instruments for valuable contributions and interventions.</td>
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<tr>
<td>Lecture notes</td>
<td>The skript can be downloaded from the student-server.</td>
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</tr>
<tr>
<td>Literature</td>
<td>The learning material can be downloaded from the student-server: atp://brillembourg-klumppner-server.ethz.ch</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Please check also the Chair website: <a href="http://u-tt.arch.ethz.ch">http://u-tt.arch.ethz.ch</a></td>
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</table>

EXERCISE

After each lecture, students are asked to produce an exercise based on the presented tools. The format of the exercise is an A3 or an A4, according to the given template. Each student has one week to prepare each exercise, and it should be delivered, in form of a physical copy, in the next lecture. (Language: preferably English, German). The Exercise tasks are a valuable preparation for the Exam (Exam only relevant for the “Jahreskurs” students) therefore it is highly recommendable to finalize all weekly Exercise tasks, as an individually conducted piece of work.

“Semesterkurs” (semester course) students from other departments or students taking this lecture as GESS / Studium Generale course as well as exchange students must submit a research paper, which will be subject to the performance assessment; “Bestanden” (pass) or “Nicht bestanden” (failed) as the performance assessment type, for “Urban Design I: Urban Stories” taken as a semester course, is categorized as “unbenotete Semesterleistung” (ungraded semester performance).

►►► Examination Block 2

Students are free to take the exam either in German or in French. They may choose between 851-0710-00L Introduction to Law for Civil Engineering and Architecture or 851-0709-00L Introduction to Civil Law (French).

<table>
<thead>
<tr>
<th>Number</th>
<th>Structural Design III</th>
<th>O</th>
<th>3 credits</th>
<th>3G</th>
<th>J. Schwartz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Title</td>
<td>Credits</td>
<td>Type</td>
<td>Professor</td>
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<tr>
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</tr>
<tr>
<td>051-0519-00L</td>
<td>Building Physics II: Moisture</td>
<td>O 3</td>
<td>3G</td>
<td>T. Defraeye</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>70% of all construction problems are related to moisture. This course aims at providing the necessary theoretical background in order to foresee and avoid these problems.</td>
<td></td>
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<tr>
<td></td>
<td>Objective</td>
<td>to develop a basic understanding of mass transport and buffering to become aware of potential moisture-related damage and health risks to learn how to (i) design building components and (ii) assess their hygrothermal performance</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Content</td>
<td>hygrothermal loads conservation of mass dry air: constitutive behaviour, transport, potential problems and solutions moist air: constitutive behaviour, transport, potential problems and solutions liquid water: constitutive behaviour, transport, potential problems and solutions moisture-induced degradation processes case studies exercises</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Handouts, supporting material and exercises are provided online (<a href="http://www.carmeliet.arch.ethz.ch/Education/">http://www.carmeliet.arch.ethz.ch/Education/</a> with Building Physics II: Moisture in the Documents section). The course syllabus can be bought at the Chair of Building Physics.</td>
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<tr>
<td>Literature</td>
<td>All material is provided online (<a href="http://www.carmeliet.arch.ethz.ch/Education/">http://www.carmeliet.arch.ethz.ch/Education/</a> with Building Physics II: Moisture in the Documents section)</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prior knowledge of &quot;BP I: heat&quot; is required.</td>
<td></td>
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</tr>
<tr>
<td>051-0551-00L</td>
<td>Energy- and Climate Systems I</td>
<td>O 2</td>
<td>2G</td>
<td>A. Schlüter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and climatisation of buildings and their interaction with architecture and urban design. Using calculations, students learn to aquire relevant numbers and assess the performance of solutions.</td>
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<tr>
<td></td>
<td>Objective</td>
<td>The lecture's target is the knowledge of the physical basics and technical components of relevant systems for a efficient and sustainable climatisation and maintenance of buildings and their interdependency with the architectonic design and construction. By learning rough calculation methods, determination of relevant dimensions and identification of important parameters become possible. Hence, adequate approaches for the own design can be chosen, reviewed quantitatively and qualitatively and set in with a synergistic effect.</td>
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<tr>
<td></td>
<td>Content</td>
<td>1. Introduction 2. Thermal systems 3. Ventilation 4. Daylight and artificial lighting</td>
<td></td>
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<tr>
<td>Lecture notes</td>
<td>The Slides from the lecture serve as lecture notes and are available as download.</td>
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<tr>
<td>Literature</td>
<td>A bibliography will be distributed at the beginning of the lecture.</td>
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</tr>
<tr>
<td>851-0703-01L</td>
<td>Introduction to Law for Architecture</td>
<td>W 2</td>
<td>2V</td>
<td>G. Hertig</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Only for Architecture BSc.</td>
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<tr>
<td></td>
<td>Abstract</td>
<td>Students who have attended or will attend the lecture &quot;Introduction to Law for Civil Engineering &quot; (851-0703-03L) cannot register for this course unit.</td>
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<tr>
<td></td>
<td>Objective</td>
<td>This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.</td>
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<td></td>
<td>Content</td>
<td>Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes. 1. Public Law Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law. 2. Private law Contracts: contractual freedom, formation and breach of contracts, basics of sales and lease contracts. Tort law: negligence and strict liability, liability limitations. Basics of corporate and civil procedure law.</td>
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<tr>
<td>Lecture notes</td>
<td>There will be 'Lecture Notes' (in German) for this course, beginning in Fall 2015</td>
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<tr>
<td>Literature</td>
<td>Further information is available at <a href="http://www.hertig.ethz.ch/courses.htm">http://www.hertig.ethz.ch/courses.htm</a></td>
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<tr>
<td>851-0709-00L</td>
<td>Introduction to Civil Law</td>
<td>W 2</td>
<td>2V</td>
<td>H. Peter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.</td>
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<tr>
<td></td>
<td>Objective</td>
<td>Enseignement des principes du droit, en particulier du droit privé. Introduction au droit des obligations. Le cours cherche à rendre accessible le droit des obligations, a son niveau, mais aussi pour l'approche des situations juridiques. Il est donc à l'intersection entre le droit des obligations et le droit des contrats. La théorie est donc à l'assistance des étudiants, qui ne sauraient pas s'orienter dans l'immensité des textes de loi. En tout cas, il est nécessaire de connaître le droit des obligations pour une approche correcte des situations juridiques.</td>
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<tr>
<td></td>
<td>Content</td>
<td>Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des librairies.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours &quot;Recht I&quot; et &quot;Recht II&quot; en langue allemande et des exercices y relatifs. - Les examens peuvent se faire en français ou en italien. - Examen au 1er propédeutique; convient pour travail de semestre.</td>
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</tbody>
</table>
The two-semester course offers an introduction to the history and theory of architecture from the industrial revolution up to now. Based on current questions a variety of case studies will be discussed.

The aim is to give an overview on crucial events, works of art, buildings and theories since the beginning of the 19th century up to today. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.

The subject of this lecture course is the history and theory of architecture since the beginning of the 19th century up to now. It examines the architectural answers to the changing technical inventions and social practices. Consequently, the focus will be less on individual architects or buildings than on various themes that determined the architecture of the period.

The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the historical plannings and methods of European cities. Each specific urban development will be presented within a broader context.

The city between Absolutism and Enlightenment: baroque defence-designs, the European colonization of the American continent and the reconstruction of Lisbon

11. Neoabsolute power, bourgeois self-confidence and Marxian Idealism: The Viennese Ringstrasse and Ildefonso Cerdas Ensanche for Barcelona

The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30.-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

Further recommended literature to consult is listed within the script. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.

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The aim is to give an overview on crucial events, works of art, buildings and theories since the beginning of the 19th century up to today. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.

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Further recommended literature to consult is listed within the script. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.
## Content

The two-semester course offers an introduction to the history of modern and contemporary art and architecture since ca. 1970. Motivated by questions of the current discourse, central topics and exemplary works of art and architecture are discussed. Concepts such as "labor", "economy", "experience", "research", "nature", "diversity" or "surface" are used to focus on specific historical developments and connections. Art and architecture is considered as a field of cultural change as well as an indicator of social, economic, and political conflicts which in turn helps to understand historical dynamics. The course "Lehrkanapé" (one hour) is part of the course and treats alternative methods of teaching and learning.

## Lecture notes

http://www.ursprung.arch.ethz.ch/courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>051-0615-00L</td>
<td>Design and Strategies in Urban Space I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>K. Christiaanse, M. Wagner</td>
</tr>
<tr>
<td>051-0757-00L</td>
<td>Building Process I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>S. Menz</td>
</tr>
</tbody>
</table>

## Literature


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**051-0155-00L** Architectural Technology V

**Abstract**

The lecture series explores the correlation among intentions of design, architectonic expression and construction premises. These critical areas or aspects of study, which are presented with selected projects, their respective theoretical backgrounds and historical development, are pluralistically associated and brought into relation with varying contemporary opinion.

**Objective**

The final part of the lecture series Konstruktion V/VI aims to analyse (structural) construction techniques and their formal appearance and expression in their interrelation. The different themed parts of structural design, building shell and knowledge of material get connected with architectural design in practice and reflected in the wider context of architectural theory. The intention is to consolidate the understanding of the connection between structure, process and formal appearance and expression in the architecture of the 20th century.

**Content**

The lecture series in each entitled Architecture and Construction explores the correlation among intentions of design, architectonic expression and construction premises. Each lecture is focused on individual themes, as for example, the application of certain materials (glass, or natural stone), of particular construction systems (tectonic, hybrid) or design generators (grids, series) and alternatively the search for a definable, tangible architectural expression (vernacular architecture, readymades). These critical areas or aspects of study, which are presented with their respective theoretical backgrounds and historical development, are pluralistically associated and brought into relation with varying contemporary opinion. The yearlong lecture cycle is comprised of twenty individual lectures, in which the majority of projects being analyzed date from the last few decades.

**Lecture notes**

no script

**Literature**

list of literature per lecture

**Prerequisites / notice**

General remarks (on exam as well as exam preparation)

The comprehensive topics of the lectures are the subject matter of the exam. The lectures are scheduled for a full year (Konstruktion V/VI) and therefore the knowledge of the subject matter of the running as well as of the preceding semester's lectures is required. To improve your chances to pass the examination at first try, we strongly recommend you to take the exam after having visited the lecture during two semesters. If you are an exchange student, or a student from a different department and wish to take a partial examination covering only the subject matter of the last semester (Konstruktion V or VI), you need to contact the chair in advance.

The brochures published by the chair offer additional help. Knowledge of these brochures and their key subjects is recommended for the exam. The brochures can be ordered at the chair after the last lecture before the examination. However, the subject matters of the brochures and the lectures are not identical, the brochures provide information for a deeper understanding of the lectures. Apart from additional articles written by the chair, the brochures are composed of three modules: Project documentation, crucial texts on the work reception as well as theoretical articles about the particular thematic priorities by various authors. Concerning their content these anthologies allow insights into a wide range of theories, lines of reasoning and fields of research up to diverging point of views of specific problems.

**051-0615-00L** Design and Strategies in Urban Space I

**Abstract**

Means and potentials of urban design are depicted from different perspectives to illustrate how the city can be designed as a sustainable autonomous work of art will be opposed with each other. The complexity of terms like meaning in an architectural context will be demonstrated with case studies of contemporary architecture, in addition to the aesthetics of the building there are the ecological boundaries and limitations. Nature and technology as imaginary utopias or the myth of timeless way of building versus the edifice as expression in a theory, and how is it interpreted by critics? What is the role of conventions in this process? Does theory evolve before, during or after the design process? Departing from these, and similar, questions, the course seeks insights into the dialectics between built work and theory, or, rather, between built work and interpretation.

**Objective**

This lecture series imparts advanced expertise in urban planning. The main focus is to illustrate the complex manner in which various themes are embedded in the everyday practice of planning and design by addressing pressing questions of contemporary urban design practice and theory. The goal is to communicate a broad-based systemic knowledge base, which helps enable students to synthesize and evaluate complex urban design and planning problems.

**Content**

The fall semester introduces the notion of strategic design and imparts further knowledge about the structure and models of the contemporary city. It is structured in two parts:

Part 1: Strategic Design

The first part of the lecture series imparts general basics to understand the city and the field of urban design. Different approaches and methods of analysis are presented, the dealing with uncertainty in planning is addressed and practical methods of urban design are identified.

Part 2: Structures and Models

Urban space is shaped on different levels. The city ground plan, the relationship between public and private space, the infrastructure and mobility needs as well as various spatially relevant stakeholders offer the basic means to steer the development. The second part of the lecture series is dedicated to these structures of the city and to the models describing them.

**Lecture notes**

There is no script accompanying the lecture series. At the end of the semester the lecture slides and at the end of the 3rd year course a reader with secondary literature will be available for download on the homepage of the chair of architecture and urban design:

http://www.christiaanse.arch.ethz.ch

**Literature**

At the end of the 3rd year course a reader with secondary literature will be available for download on the homepage of the chair of architecture and urban design: http://www.christiaanse.arch.ethz.ch

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### Examination Block 5

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>051-0115-00L</td>
<td>Theory of Architecture I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>A. Moravanszky</td>
</tr>
</tbody>
</table>

**Abstract**

The first series of lectures studies existing models of the construction of theory in the works of specific architects. How does a coherent architectural language of form arise? How is it conceptualized by the architects themselves? How is it verbalized, how does it find expression in a theory, and how is it interpreted by critics? What is the role of conventions in this process? Does theory evolve before, during or after the design process? Departing from these, and similar, questions, the course seeks insights into the dialectics between built work and theory, or, rather, between built work and interpretation.

**Objective**

The lecture series of architecture theory is continued with a comparison of different approaches to define architecture and to discuss its boundaries and limitations. Nature and technology as imaginary utopias or the myth of timeless way of building versus the edifice as autonomous work of art will be opposed with each other. The complexity of terms like meaning in an architectural context will be demonstrated with case studies of contemporary architecture, in addition to the aesthetics of the building there are the ecological boundaries and limitations. Theory aims at the goal to make these realms transparent and describable. Finally we will discuss the question, in as much architectural design as a process of reflection and projection incorporates already an utopian dimension.
The building process is the main focus of this lecture series. The process is understood as a sequence of criteria in time. These criteria are divided into acquisition and building legislation, building economics and facility management, the people involved and their work, construction and planning organization. Process thinking and interdisciplinary and process-oriented thinking on the part of students is a prerequisite.

Lectures

- Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009

Handouts and literature will also be provided for this purpose. The students are additionally requested to contact the Chair.

Subjects with Semester Grade (Only for Programme Regulations 2007)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0713-00L</td>
<td>CAAD I</td>
<td>O</td>
<td>0 credits</td>
<td>2G</td>
<td>L. Hovestadt</td>
</tr>
</tbody>
</table>

The course has been divided into a lecture series given by Prof. Ludger Hovestadt, as well as lectures and tutorials to the accompanying exercises. Each semester, several exercises in six different in-depth themes are offered in small groups in a seminar format, from which one exercise must be completed per semester. The exercises will be graded. Attendance to lectures is mandatory!

Introduction to information technology for architects. First, theoretical part. Information technologies are today a constituent part both for architectural work and our built environment. Hardware and software are pervasive, inexpensive and easy to use. Conventional planning and building processes are accelerated and improved in the good case. In this course we ask the qualitative question about new attitudes and meanings on this new plateau. CAAD I describes this new plateau in its different facets in the lectures. CAAD I closes off with an experimental exercise beyond the possibilities of the usually employed commercial hard- and software.

Introduction to information technology for architects. First, theoretical part. Information technologies are today a constituent part both for architectural work and our built environment. Hardware and software are pervasive, inexpensive and easy to use. Conventional planning and building processes are accelerated and improved in the good case. In this course we ask the qualitative question about new attitudes and meanings on this new plateau. CAAD I describes this new plateau in its different facets in the lectures. CAAD I closes off with an experimental exercise beyond the possibilities of the usually employed commercial hard- and software.

The course has been divided into a lecture series given by Prof. Ludger Hovestadt, as well as lectures and tutorials to the accompanying exercises.

Architectural Design and integrated Disciplines

Architectural Design

Architectural Design (3. Semester)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-1501-15L</td>
<td>Architectural Design III: From the City to the House (D.Eberle)</td>
<td>W</td>
<td>12 credits</td>
<td>12U</td>
<td>D. Eberle</td>
</tr>
</tbody>
</table>

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php). Students who do not wish to change the design class must not enrol.

The design course is built on various exercises. During Fall Term, the students are concerned with the conversion and densification of existing building structures at three different sites in Zurich.
Conveying a way of thinking that is also able to understand complex contexts and act on various levels is one of the focuses of the chair. This networked thinking relates to pragmatics and educates the students to be competent architects. Achieving this goal requires a method that teaches a clearly structured, precisely formulated approach and communicates the simultaneity of complex tasks and processes.

The design course is built on four exercises. Based on the existing buildings, the themes Place, Structure and Shell are being examined - first separately and then combined in a final project. The extension and densification of existing building structures are being carried out at three different sites in Zurich; the new use is planned for work and living. The exercises are divided into a City Level and a House Level. At the City Level a group of students examines the three building sites according to each theme. At the House Level the students develop designs addressing the themes in groups of two.

Exercises will involve design and construction, from the definition of a concept to the execution of the detailed work. Work will include procedural methods for spatial designs through form, function, technology, and materials. To promote interdisciplinarity through integrated teaching.

Achieving the goal of competent architects requires a method that teaches a clearly structured, precisely formulated approach and communicates the simultaneity of complex tasks and processes.

The target of the design work is to improve and widen the basic knowledge of domestic architecture and housing and also to get to the singularity of each place is the promise for an overall more differentiated living space.

The aim of the course is to reinforce the sensibility for such a broad attitude and at the same time to develop the skills for its application. To deal with the reality of construction and material is thereby an important concern.

The exercises are divided into a City Level and a House Level. At the City Level a group of students examines the three building sites first separately and then combined in a final project. The extension and densification of existing building structures are being carried out at three different sites in Zurich; the new use is planned for work and living.

The studio takes this opportunity to explore the same issue of obsolescence in two different cities, cultures and time through the means of design and research. We aim to exchange the thoughts of the difference and sameness; and to ultimately develop a new prototype in form and urbanism to implement in both contexts.

### Architectural Design (from 5. Semester on)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td></td>
<td>Please register (<a href="http://www.mystudies.ethz.ch">www.mystudies.ethz.ch</a>) only after the</td>
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<td>internal enrolment for the design classes (see</td>
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<td></td>
<td><a href="http://www.einschreibung.arch.ethz.ch/design.php">http://www.einschreibung.arch.ethz.ch/design.php</a>). Students who</td>
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<td>do not wish to change the design class must not enrol.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>These days architecture is affected by increasingly similar images.</td>
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<td>We want to turn to another reality - the place. The strengthening</td>
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<td>of the singularity of each place is the promise for an overall</td>
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<td>more differentiated living space.</td>
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<td><strong>Objective</strong></td>
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<td>Architecture requires a fine perception of the existing and a brave</td>
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<td>vision for the future. The condition for both is a firm attitude</td>
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<td>coming out of a living collective.</td>
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<td><strong>Content</strong></td>
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<td>Wir werden uns im Semester mit der Idee «Origen» beschäftigen</td>
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<td>und zusammen mit Giovanni Netzer versuchen einen Beitrag zu einer</td>
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<td>Verdichtung zu erreichen. Wie kann das Zusammenleben von Dorfbewohnern</td>
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<td>und Ortens Künstlern, Gästen und Mitarbeitern weitergedacht werden?</td>
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<td>Welche Wohnformen vermitteln den Bewohnern Geborgenheit? Mit diesen</td>
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<td>Fragen werden wir uns beschäftigen und an mehreren Orten im Dorf Riom Wohnräume entwerfen.</td>
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<td>Arbeitsort: Atelier Gisel, Streulistrasse 74a, 8032 Zürich</td>
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<td>Anzahl Studierende: 16</td>
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<td><strong>Einführung:</strong> Dienstag, 15. September 2015, 10.00 in Riom</td>
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<td>Ausführliches Semesterprogramm: <a href="http://www.caminada.arch.ethz.ch">www.caminada.arch.ethz.ch</a></td>
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<td>Assistenten: Thomas Stettler, Silvan Blumenthal, Franziska Wittmann</td>
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| 051-1103-15L | Architectural Design V-IX: Spatial Transformation in the Age of Obsolescence (Guest Prof. D. Liu) | W | 13 credits | 16 U | D. Liu, further lecturers |
|              | Please register (www.mystudies.ethz.ch) only after the               |      |      |       |                         |
|              | internal enrolment for the design classes (see                      |      |      |       |                         |
|              | http://www.einschreibung.arch.ethz.ch/design.php). Students who    |      |      |       |                         |
|              | do not wish to change the design class must not enrol.             |      |      |       |                         |
|              | **Abstract**                                                        |      |      |       |                         |
|              | Zurich - Guangzhou                                                   |      |      |       |                         |
|              | The Studio takes the opportunity to explore the same issue of       |      |      |       |                         |
|              | obsolescence in two different cities, cultures and time through the |      |      |       |                         |
|              | means of design and research. We aim to exchange the thoughts of   |      |      |       |                         |
|              | the difference and sameness; and to ultimately develop a new       |      |      |       |                         |
|              | prototype in form and urbanism to implement in both contexts.      |      |      |       |                         |
|              | **Objective**                                                        |      |      |       |                         |
|              | As an architect, how to reconsider the spatial potentials to        |      |      |       |                         |
|              | accommodate urban life, culture and the future in a more creative  |      |      |       |                         |
|              | and original way, it is a challenge.                                |      |      |       |                         |
|              | The studio takes this opportunity to explore the same issue of      |      |      |       |                         |
|              | obsolescence in two different cities, cultures and time through the |      |      |       |                         |
|              | means of design & research. We aim to exchange the thoughts of the |      |      |       |                         |
|              | difference and sameness and to ultimately develop a new prototype  |      |      |       |                         |
|              | in form and urbanism for the places in similar.                    |      |      |       |                         |
Never before the world has seen such levels of connectivity and interaction between people as it is happening in the beginning of the XXI century. Urbanization, democratisation of air travelling and widespread access to telecommunications make us global citizens. Cultural exchange happens everywhere at any time. Post-colonial, post-industrial times require parallel, alternative ways of thinking to deal with the legacy of all kinds of built structures. Reuse, refurbishment, transformation, demolition, substitution. What is our attitude as architects? What is the role of architecture in such a fast-changing world?

Welcome to the age of obsolescence!

"Draw from the heavens to the drawing board", this quote - the title of an essay collection by East German architect Herman Henselmann - Portraits is a series of critical assessments on contemporary issues. Its specificity lies in the association of mutually enlightening, yet seemingly antagonistic programs. Its method claims no historical loyalty, as sources and facts are being intentionally set up to serve a reducing purpose. Portraits evaluates contradictory encounters and stresses cross-fertilization as a key asset in the design process.

**Content**

051-1107-15L

Architectural Design V-IX: Open (Gastdozentur)  
W 13 credits 16U to be announced

Abstract

Portraits III: Territory/Politics  - "Ce n'est ni la situation, ni la grandeur, ni la richesse des capitales qui causent leur prépondérance politique sur le reste de l'Empire, mais la nature du gouvernement" (Alexis de Tocqueville in: L’Ancien Régime et la Révolution).

Objective

Portraits is a series of critical assessments on contemporary issues. Its specificity lies in the association of mutually enlightening, yet seemingly antagonistic programs. Its method claims no historical loyalty, as sources and facts are being intentionally set up to serve a reducing purpose. Portraits evaluates contradictory encounters and stresses cross-fertilization as a key asset in the design process.

051-1113-15L

Architectural Design V-IX: Eastopia - Utopia in the People's Republic of Poland (M. Angélil)  
W 13 credits 16U M. Angélil

Abstract

In the studio we will move between a landscape of ideas and the actual built landscape in East Germany, between visions and shrinking cities, between different social systems and layers of time with the goal of recovering interesting concepts from failed plans.

Objective

Develop various analytical and notation techniques for understanding culturally/ideologically molded architectural landscape; theoretical discussion of the social and architectural types of socialism with visionary potential; critical evaluation of compiled instruments; designing relevant architecture through examination of East Germany.

Content

"Draw from the heavens to the drawing board", this quote - the title of an essay collection by East German architect Herman Henselmann - speaks of the euphoria, the optimism of progress, and the belief in the messianic potential of architecture and city planning characteristic of the early years of the GDR (1). Particularly when it was a young socialist state, the hope reigned that a better and more equal society could be developed through urban planning and architecture. The many socialist utopias are products of this revolutionary thinking. As the state actually developed, however, an ever-greater disillusionment grew instead. The initial hope dimmed in the face of authoritarian government condemnation that is now being questioned.

In the studio we will pursue the assumption that many of the hopeful utopian approaches and social attitudes upon which the socialist types were based could still be of interest today. In this sense, we will move between a landscape of ideas and the actual built landscape, between visions and shrinking cities, between different social systems and layers of time with the goal of recovering interesting concepts from failed plans.

The first step will be an archaeological investigation of the utopian fragments within the ruins of former visions, assembling an inventory of projects and socialist types with visionary potential. In a critical reflection from a contemporary perspective, the content of the architectural imprint of socialism is to be explored in order to find tools for dealing with today’s territories of emigration and economic collapse.

In this way, could it be possible to develop a future for East Germany and elsewhere that doesn't put a false ‘heaven’ of growth and repopulation back on the drawing board, but rather, considerately and critically continues the past trajectory in a new light? Could we develop both visionary and pragmatic architectural interventions that enliven the landscape without actually imagining that it flourishes? (2)


Lecture notes

A semester reader with all important text sources and additional material will be provided.

Prerequisites / notice

Integrated Discipline Planning (P) included LV No. 063-1401-14

- Course numbers for inscription:  
  LV No. 051-1113-14 U (Design)  
  LV No. 063-1401-14 (Integrated Discipline Planning)

- Work format: individual and group work

- Assistants for the design course:  
  Michael Hirschbichler, 044 633 38 21, hirschbichler@arch.ethz.ch  
  Marcin Ganczarski  
  Ciro Miguel


- Course introduction/Special event: 16.09.2013, 10:30h, ONA studio;

051-1115-15L

Architectural Design V-IX: Manifesta HS15 (Emerson)  
W 13 credits 16U T. Emerson

Abstract

This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).
Objective: Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

Street (A. Gigon/M.Guyer) ■

Abstract: Designing Architecture, which sounds the potential of its usage, its location, the city, the society and its culture and transforms these into a coherent spatiality and materiality by a distinct concept.

Objective: Capability to develop a design from an idea, a concept to an advanced project, to question the intermediate stages in a self-critical way, thereby finding an individual design method and attitude.

Content: Design work in different fields of architecture and urbanism with integration of the knowledge acquired in the first years of studies, supported by experts in related sciences (e.g. structural engineering, landscape architecture, history of art and architecture, historic preservation etc.)

Project (D.Hebel) ■

Abstract: The studio will plan a school complex for approx. 600 students near Phnom Penh, Cambodia. Here, class rooms, general assembly rooms and necessary infrastructures need to be integrated in an already existing rural neighborhood. Attention has to be given to the climatic condition, available resources and the development of easily applicable construction principles.

Objective: It is the educational objective to teach students a socially responsible intercourse between the discipline of architecture and clients belonging to a low- or no-income group in one of the poorest societies of the world. Future urbanization will happen mostly in these developing territories. It is the aim of the course to equip students with the ability to understand and act in such territories and to develop the necessary skills to propose meaningful and engaged design strategies which are developed and operate from within a field of first hand knowledge. Design decisions should be based on questions of climatic conditions, availability, responsibility, functionality and the respect for social and cultural settings. Students will start their design work by studying those local conditions through field research with local architects and decision makers. Designs will react to those findings by proposing adequate strategies on the neighbourhood as well as the object level. It is the aim to develop construction methods and details, which will react and respect local available skills as well as materials and deepen this thinking by an integrated structural design component together with the Professorship of Building Structure as well as the Professorship of Building Systems. In addition, financial impacts have to be kept in mind. It is also important to interact with local architects and planners.

Content: We plan within the specific context of a society which is dominated on one hand by the fascinating history of the Khmer culture and on the other hand a dramatic demographic development due to the brutal civil war in the recent past. 52.1% of the population of Cambodia are under the age of 24 years, the average of the total population is 23.5 years. The question of education and care is thus socially relevant and urgent.

In addition to these specific social conditions, the availability of material resources, talent and technical skills as well as the climatic, ecological and economic conditions have to be considered in the design. The question of contemporary didactical concepts and their spatial implementation is an important issue in the semester. Together with local professionals we will develop a reasonable and customized strategy how the school system and the necessary infrastructure can be implemented in several phases. It is the declared aim of the course to develop designs that are feasible in terms of architecture and construction, from urban and neighborhood issues to the constructive detailing of individual buildings. The results of the studio should be a relevant contribution to the contemporary architectural culture of Cambodia, respecting the specific social and climatic conditions. The client considers the realization of the project.

The Professorship offers this course together with the integrated discipline Construction. The Professorship of Architecture and Structure, Prof. Philippe Block offers the integrated discipline Structural Design and the Professorship of Architecture and Building Systems, Prof. Arno Schlüter offers the integrated discipline Building Systems (climatic questions).

Prerequisites / notice: A seminar week is offered on this subject to interested students. Participation is strongly recommended but not mandatory.

(K. Christiaanse) ■

Abstract: This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Objective: The goal is to communicate a broad-based systemic knowledge base, methodologies and strategies, which helps to enable students to evaluate complex urban design and planning problems and to synthesize their knowledge in an urban design project.

Prerequisites / notice: Detailed information on design studios will be announced in advance to the registration process on the homepage of the chair of architecture and urban design: http://www.christiaanse.arch.ethz.ch

The number of participants is limited to max. 36 students.

051-1123-15L Architectural Design V-IX: A Proposal (Guest Lecturer W 13 credits 16U P. Flammer)
P. Flammer) ■

Abstract: Starting position are your thoughts, wishes and imagination from what you formulate your architectonic idea. This idea, in general, should be explicable and conceptual. Thereof you generate a form. So, the construction is relevant and not the evolutionary history anymore. Hence, this construct can't be the solution, but a proposition.

Objective: Competence to generate a architectonic project out of a own idea.

Höngg (M.Sik) ■
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

051-1129-15L Architectural Design: Villa Housing City (M.Peter) ■
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
Architectural design based on place, category, modification and built form.

Objective
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Content
WINERY "CHILLESTEIG", ZÜRICH-HÖNGG:
The "Chilleteig" winery is located just below the Höngg cemetery, facing south toward the "Europa" bridge and the Limmat. Architecture and Wine go together well. An exceptional design of landscape, building and space in combination with upscale interior and exhibition architecture contribute to the unique atmosphere of the winery - which includes a wine press, a wine tasting bar, a venue for shows and an exhibition space.

The immediate context - architecture of Höngg and Zürich - provide the main points of references for shape and atmosphere.

Prerequisites / notice
- Accompaniment by Professur für Landschaftsarchitektur Günther Vogt
- Integrated Discipline Focal Work Construction, D.Mettler/D.Studer, Bautechnologie und Konstruktion 051-1201-15 L
- Integrated Discipline Focal Work Construction, D.Mettler/D.Studer, Bautechnologie und Konstruktion 063-1337-15 L
- Critics every 2 weeks
- Professur Miroslav Sik, HIL G7S.2, Tel 044 633 28 13, Fax 044 633 10 81, sik@arch.ethz.ch
- Introduction 15.09.15, 10.00 Uhr, HIL G61

051-1131-15L Architectural Design V-IX: Modern Cities - Réinventer
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
The analysis of the un-built territory of Basel will be the pre-requisite for interventions that aim at tackling the disconnection between current forms of urbanization and territory. Students will advance alternative architectural visions for Basel's river valleys, ones that put at the centre the articulation of the limit, understood as the place able to inform the experience of architecture.

Objective
Each student's team will develop a component of a common project for the region of Basel that will result in a unitary proposal for the entire territory. Participants will become acquainted with large-scale design and will work at the intersection between architecture, urban design and landscape. Throughout the semester, emphasis will be posed on issues of representation and communication.

Content
The studio aims at investigating the problems of land, landscape and resources consumption that contemporary urbanization implies. By shifting attention towards land, landscape and the entire un-built territory students will focus on the idea of the limit, the physical space of delimitation and separation between two different conditions and the place able to inform the experience of architecture.

Literature
A reader with relevant literature will be distributed to all participants at the beginning of the semester.

051-1133-15L Architectural Design V-IX: Lyon: trois montagnes, trois rivières, trois parcs, trois échelles (Vogt) ■
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
The Alps as Common Ground

Objective
Independent thinking and acting.
The Alps as Common Ground

With each design semester the Chair of Professor Vogt is working its way around the Alpine arc with the thesis that it can be read as an urban Common Ground. The task of each design semester is to verify this thesis by focusing on a metropolitan region and enquiring as to its specific relationship with the Alps.

In the coming semester we shall be working with the urban territory of Lyon, which snakes between the Massif Central, Jura mountains and the Alps and reaches from the Mediterranean via the plateaus of the Bas-Dauphiné, Bresse and Dombes right up to the roof of Europe, Mont Blanc, 4,810 metres above sea level.

We understand design not as an end product but as a process. Our first step is to investigate Lyon’s large scale relationships. A four day long field trip complements this analytical gaze with a personal take on the area. Students then develop an individual programme as the foundation for their design. The proposed interventions can vary between urban planning and landscape scenarios and concrete architectural proposals.

Lecture notes
The Workbook is released in the first week.

Literature
The relevant literature is included in the workbook.

Prerequisites / notice
Process Cartography
Chair of Günther Vogt
www.vogt.arch.ethz.ch
Contact: kissling@arch.ethz.ch
Assistants: Sebastiano Brandolini, Thomas Kissling, Roland Shaw, Ilkay Tannrisever
Design (051-1135-15 U - 13 KP) and integrated discipline planning / landscape architecture (051-1235-15 U - 3KP)
The trip to Lyon takes place between 02.10.15 - 05.10.15. The contribution towards expenses will be 220 CHF.

Content

Throughout the semester, students will focus on developing transferable and practical skills - such as:

- Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design
- Looking at the history of art in European society, specifically charting how the development of art has come out of, and reflects the different contexts for which it is made and displayed. We will look in considerable detail at specific installations from the chapel where people were praying in a chapel, debating matters of state in parliament, or enjoying cakes and tea at home. In order to narrow down the theme of the project for the semester, students will begin developing individual design proposals for their specific and more unique goods.

- Developing drawing and modelling skills across a variety of media to represent architectural and urban ideas.
- Responding to the complexities of urban problems through architectural solutions in the context of economic, social and cultural change.
- Analysing the various layers that shape a community (social, economic, infrastructural, cultural, historical).
- Anticipating the positions of producers and consumers from local, national and international levels of activity.
- Bridging top-down planning with bottom-up practices.
- Addressing changing demands of consumers and producers in industrialized countries.

Lecture notes

The design studio is also planned in conjunction with the Seminar Week trip to San Patrignano, Italy through the Brillembourg & Klumpner Chair of Architecture and Urban Design. Enrollment in the San Patrignano Seminar Week is NOT REQUIRED but is highly recommended as it forms an essential part of the studio and maximizes design output.

Prerequisites / notice

For more information on this course, please refer to our Chair's website: http://u-ut.arch.ethz.ch/classes/051-1141-15L

Integrated Discipline: Urban Design
Language: English
Work: Groups (analysis) - Individual (design project)
Location: GNA
Chair: Prof. Brillembourg & Prof. Klumpner
Assistant: Hannes Gutberlet, Katerina Kourkoula, Gianmaria Socci, Danny Wills

Class material can be downloaded from the student-server.

For decades, our society has been increasingly facing an alienation from the production of food and consumer goods in general. Industrialization and mass production allowed higher efficiencies, lower prices and larger quantities while securing a comfortable level of supply for most industrialized countries. Mass consumption in highly specialized supermarkets and department stores has been the consequence and become the norm. Each production and marketing strategy is carefully implemented or quickly adapted according to changing demands. As a consequence, today, a growing number of consumers apply a desire goods that are produced locally, sustainably or organically. And the industry has equally diversified its branding strategies. Terms such as green, organic, sustainable and local have become important adjectives for marketing campaigns, often disguising and ridiculing the actual origin of a product. As green is going mainstream it is becoming increasingly difficult to distinguish between packaging and product.

Consequently, authenticity and specificity have become rare goods for those new consumers in search for a more special and refined product. They are becoming increasingly interested in the origin of their purchased goods. The producer has become part of their decision process. In many cities the rather old-fashioned concept of a weekly market has turned into a newly branded farmer's market. It is the stories these local producers tell and the authentic image they personify that add to the purchasing experience and (better) conscience of their customers. While for the majority of consumers the price of a good still seems to outweigh its quality, there is a new tendency of local small-scale producers to capitalize on their limited capacity and regional uniqueness. They have created their own niche markets for specific and more unique goods.

There exist few examples where small communities have managed to distance themselves from the downsides of industrial production. These exceptional communities offer rejuvenated forms of collective production while producing highly competitive products for a variety of customers. Although a community producing food and other goods is not a particularly new phenomenon, such small-scale environments seem to offer refreshing conditions for people to re-engage with the origins of their consumer goods. This semester we intend to re-investigate this relationship between producer and consumer from a newly conceived spatial perspective.

The Italian village of San Patrignano in the Emilia-Romagna province is a unique community that is in a constant state of internal transformation and adaptation. The high degree of self-sufficiency is at the same time part of its existence and nationwide success. Originally founded in 1978 to provide secluded spaces for drug-rehabilitation, San Patrignano today consists of around 1600 residents. While overcoming their former drug-addiction the residents live and work together in a small hillside enclave, isolated from inner-city temptations. Part of their rehabilitation therapy is to spend time learning to produce and further advance the production of food, furniture and other goods. These unique products are then consumed and sold locally or beyond its borders.

San Patrignano's growth pattern has always followed a path of improvisation and step-by-step planning. The success of its rehabilitation method has evolved into an increasing demand for additional living spaces. Simultaneously, there appears to be a great potential to also extend and rethink the spaces where goods are produced, presented and purchased.

Originally founded in 1978 to provide secluded spaces for drug-rehabilitation, San Patrignano today consists of around 1600 residents. San Patrignano's growth pattern has always followed a path of improvisation and step-by-step planning. The success of its rehabilitation method has evolved into an increasing demand for additional living spaces. Simultaneously, there appears to be a great potential to also extend and rethink the spaces where goods are produced, presented and purchased.

http://www.einschreibung.arch.ethz.ch/design.php)

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

For more information on this course, please refer to our Chair's website: http://u-ut.arch.ethz.ch/classes/051-1141-15L

Abstract

Looking at the history of art in European society, specifically charting how the development of art has come out of, and reflects the different contexts for which it is made and displayed, the project will be to design a small suite of galleries for specific collections of art, a small museum for a site in Zurich. The semester will be run in collaboration with Fredi Fischli and Niels Olsen of gta exhibitions.

Objective

Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

Content

This semester is about the production of atmosphere, about making spaces that have a precise and relevant spatial character. It was once self-evident that this was the main task of the architect, to make buildings and spaces that supported the rituals of daily life whether that was praying in a chapel, debating matters of state in parliament, or enjoying cakes and tea at home. In order to narrow down the theme of atmosphere and avoid becoming overly philosophical, we will look specifically at the installation and experience of art. We will begin by looking at the history of art in European society, specifically charting how the development of art has come out of, and reflects the different contexts for which it is made and displayed. We will look in considerable detail at specific installations from the chapel to the art fair. The main project of the semester will be to design a small suite of galleries for specific collections of art, a very small museum for a site in Zurich. The semester will be run in collaboration with Fredi Fischli and Niels Olsen of gta exhibitions.

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 64 of 1432
Architectural Design V-IX: (M. Topalovic) W 13 credits 16U M. Topalovic, to be announced

Abstract
Free diplomas are offered only, on agreement with the chair. This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g., building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Content
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Tuesday and Wednesday all day.
please note: This course takes place in 8952 Schlieren, Englischerstrasse 5 f

The Biennale project will be integrated into the Giardini, as an interdisciplinary research of statics, geometry and construction of a room

16U

Constructive and technical bearing structure problems of transformation are mainly taught. The focus is set on a creative argumentation

13 credits

Architectural Design V-IX: A Room for the Biennale ■ W 13 credits 16U C. Kerez

Abstract
The students will develop and design a room which will be built in the Swiss Pavilion of the Architecture Biennale 2016 in Venezia.

Objective
Experimental discussion to "built rooj" in the form of phisical and virtual models. theoretical discussions to "show architecture"; critical evaluation of the realized intermediate results; interdisciplinary collaboration with the chairs of Prof. Karin Sander, Ludger Hovestadt and Joseph Schwartz.

Content
The Biennale project will be integrated into the Giardini, as an interdisciplinary research of statics, geometry and construction of a room with maximal komplex room mantling. Moreover, a theoretical and historical examination of the the room development shall serve as a basis for its programming with curatic work and enable localization within the contemporary architectural discourse.

Room as a physical phenomenon:
A interdisciplinary, ETH internal collaboration within the chairs of the professors Christian Kerez (architectural design), Joseph Schwartz (chair of structural design), Ludger Hovestadt (Computer Aided Architectural Design CAAD) and Olga Sorkine-Hornung (Interactive Geometry Lab, D-INFK) will supervise a free design semester. Hence, the students' models are currently tested regarding their static powerness, producibility and room-geometric qualities, are possibly modified or produced with gained knowledge under other conditions. Target of the semester is to investigate and produce digital data, physical models and 1:1 Mock-Ups of room parts which will serve as a pre-stage for the physical production.

Room as a cultural phenomenon:
The Architectural Biennale and at the same time the possibility to present the results of this spatial, static and constructive research to the large public in a built form should be taken as occasion to stimulate a critical reflexion in form of a theoretical and historical research. At the exposition in Venice, the built room in the Swiss pavillon will be shown also as a cultural phenomenon. Therefore, on the one hand, relations to historic relevant projects and steps shall be made, on the other hand, the room should also be arranged kuratorically - this should express the attitude that architecture can be catched sterically, independently of conventions and historic references.

Lecture notes
The Reader will be handed out at the first meeting and is in English only.

Prerequisites / notice
Please enroll also for: Integrated seminar week (19.-23.10.15) in Zurich ; Cost range: A.

051-1247-15L Integrated Discipline Architecture and Art (K. Sander)
051-1223-15L Integrated Discipline Structural Design (J. Schwartz)
051-1217-15L Integrated Discipline CAAD (L. Hovestadt).


Abstract
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Objective
The goal is to communicate a broad-based systemic knowledge base, methodologies and strategies, which helps to enable students to evaluate complex urban design and planning problems and to synthesize their knowledge in an urban design project. Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

Architectural Design V-IX: Architecture & Building Structure: Track 4 - A Station with Market Hall 

W 13 credits 16U J. Schwartz, M. Beckh, A. Deplazes, D. Eberle, M. Schrems

051-1191-15L

Abstract
Constructive and technical bearing structure problems of transformation are mainly taught. The focus is set on a creative argumentation

with questions of inner power flow, of constructive execution as well as of the quality of the architectonic room. The competences of all the elective and major courses are brought together in one course.

Objective
As a didactic target a profound debate on supporting structure, on construction and on room creation is declared.

Due to the


Abstract
The HS15 design studio “at work” is following a invitation for a cooperation with the chair for the “Manifesta 11” taking place in summer 2016. It is about work places and work rooms in the city - and on how they avert from urban publicity or integrate themselves as a matter of course.

Objective
To develop concepts of architectural and urban design and its specific formulation. Understanding architecture as cultural practice with a strong but unstable connection to society, i.e. to the city and the history of our built environment. Through design and means of architecture, being able to deliver a critical contribution to a specific discourse within the disciplin. Working with the speculative reality of architecture.

In the context of the semester-long design projects, the reciprocity between design, construction and materiality is reinforced. The integration of knowledge gained in the basic courses lends the work an additional dimension and demands of the students an increased ability to think and design. This part of the curriculum addresses design work in different areas of architecture and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Suggestions will be given at the discussions. We expect that students pursue their examination of the design process independently and in an original manner or that they develop a related theme from the perspective of the history of art and architecture. The work should be part of the design process and interact with it formally and in regard to content.

### Integrated Discipline Construction

The integrated Discipline Construction can also be completed as "additional integrated Discipline", but the integrated Discipline Construction must be chosen at least once.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-1201-15L</td>
<td>Integrated Discipline Construction (D.Mettler/D.Studer)</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>D. Mettler, D. Studer</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the context of the semester-long design projects, the reciprocity between design, construction and materiality is reinforced. One focus is the coherence of design and construction. In the process of developing a project's constructional aspects, design intentions become formulated in a more precise and binding way.</td>
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<tr>
<td>Objective</td>
<td>The integration of knowledge gained in the basic courses lends the work an additional dimension and demands of the students an increasingly integrative ability to think and design.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Time and place see on <a href="http://www.buk.arch.ethz.ch/Lehr/Einfuehrungsveranstaltung">http://www.buk.arch.ethz.ch/Lehr/Einfuehrungsveranstaltung</a> .</td>
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<tr>
<td>051-1237-15L</td>
<td>Integrated Discipline Landscape Architecture (C.Girot)</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>C. Girot</td>
</tr>
<tr>
<td>Abstract</td>
<td>Design concepts ranging from architectural objects to urban planning are developed together with the discipline of landscape architecture. The city as a cultural expression has always been the critical project of architecture. By focusing on individual elements that make up the whole, a precise architectural discussion can be developed about collective form. The design process describes the ideological reshaping of a constructed idyll and the related negotiation of its resulting contradictions. The outcome is a third typology between house and city.</td>
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<tr>
<td>Objective</td>
<td>Students gain an insight into the integrated disciplines of design in architecture together with landscape architecture. The city as a cultural expression has always been the critical project of architecture. By focusing on individual elements that make up the whole, a precise architectural discussion can be developed about collective form. The design process describes the ideological reshaping of a constructed idyll and the related negotiation of its resulting contradictions. The outcome is a third typology between house and city.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>It is a must to take part in the introduction course to &quot;Integrated Discipline Construction&quot;.</td>
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</tr>
<tr>
<td>051-1241-15L</td>
<td>Integrated Discipline Construction - Autumn Semester 2015</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.</td>
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<tr>
<td>Objective</td>
<td>Work on a current design project with focus on construction.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Obtain competence in the field of construction and constructive design.</td>
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</table>

### Additional Integrated Disciplines

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The formal framework needs to be discussed with the staff members.</td>
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<tr>
<td>Objective</td>
<td>A study in building research and preservation of building heritage with a clear topic.</td>
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<tr>
<td>051-1205-15L</td>
<td>Integrated Discipline History of Urban Design (V.M.Lampugnani)</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>V. Magnago Lampugnani</td>
</tr>
<tr>
<td>Abstract</td>
<td>The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The written essay should be at least 10 pages. The formal framework needs to be discussed with the assistants.</td>
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<tr>
<td>Objective</td>
<td>An urban history case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.</td>
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<tr>
<td>Lecture notes Literature</td>
<td>There is no reader.</td>
<td>Suggestions will be given at the discussions.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Voraussatanz ist die Anmeldung unter mystudies.ethz.ch und per e-mail an die Professur bis zum Ende der ersten Semesterwoche unter Angabe des Entwurftemas und der betreuenden Professor, sowie die Teilnahme am Kolloquium in der zweiten Semesterwoche zur allgemeinen Einführung und konkreten Besprechung der Integrationsleistung (Ort und Uhrzeit des Kolloquiums werden auf der Homepage des Lehrstuhls Lampugnani bekannt gegeben). Die Abgabefrist erfolgt analog zum Entwurf.</td>
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<tr>
<td>051-1207-15L</td>
<td>Integrated Discipline History of Art and Architecture (P.Ursprung)</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>N. Zschocke</td>
</tr>
<tr>
<td>Abstract</td>
<td>Works in the integrated discipline art and architectural history evolve in close connection with projects in design. Textual and creative works are possible. The length of the text or the extent of the creative project will be decided upon individually. Interested students are asked to develop a (textual or diagrammatic) concept sketch explaining the content and the form.</td>
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<tr>
<td>Objective</td>
<td>We expect that students pursue their examination of the design process independently and in an original manner or that they develop a related theme from the perspective of the history of art and architecture. The work should be part of the design process and interact with it formally and in regard to content.</td>
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</table>
The goal is that the students learn to evaluate hygrothermal performance of the building in the different stages of the design process. The theoretical reflection on the principles which guide the design process.

Alongside a discussion of the basic principles, trends and terminologies, a closer look will be taken at each topic.

The integrated design is organized and operated by both chairs engaged in close cooperation.

Today architectural sketching without the employment of information technologies is only meaningful in exceptional cases. CAD plans, three-dimensional rendering, CNC model construction etc. are pervasive media for the development and presentation of architectural drafts. This elective course tries to follow questions on a new plateau: Which are the common traits of current design methods and modern technical applications are not meant to be of priority.

This elective course tries to follow questions on a new plateau: Which are the common traits of current design methods and modern technical applications are not ment to be of priority.
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

Objective

To consider the social context in the design process!

Content

The content is related to the design process and is defined accordingly to the individual project.
B) for D-ARCH.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses
ETH/ UZH

<table>
<thead>
<tr>
<th>Architecture Bachelor - Key for Type</th>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>W</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td></td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td></td>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<td></td>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td></td>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Integrated Discipline Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-1401-15L</td>
<td>Integrated Discipline Planning - Autumn Semester 2015</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>Lecturers</td>
</tr>
<tr>
<td></td>
<td>Please register (<a href="http://www.mystudies.ethz.ch">www.mystudies.ethz.ch</a>) only after the internal enrolment for the design classes (see <a href="http://www.einschreibung.arch.ethz.ch/design.php">http://www.einschreibung.arch.ethz.ch/design.php</a>)</td>
<td></td>
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<tr>
<td>Abstract</td>
<td>The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.</td>
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<tr>
<td>Objective</td>
<td>Work on a current or a passed design project in a large scale.</td>
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<td></td>
<td>Obtain competence in mastering complex questions relating to alternative strategies and methods in urban design.</td>
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</table>

### Integrated Discipline Focal Work (only for Programme Regulations 2007)

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.</td>
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<tr>
<td>Objective</td>
<td>A case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.</td>
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<td></td>
<td>Reflexive, consolidated analysis of independently formulated questions and aspects of the design process with related valuable addition of understanding.</td>
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<tr>
<td>Abstract</td>
<td>The focal work serves the scientifical foundation of an exemplary subject of architecture. In the context of the semester-long design projects, the reciprocity between design, construction and materiality is reinforced. One focus is the coherence of design and construction.</td>
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<tr>
<td>Objective</td>
<td>The focal of knowledge gained in the basic courses lends the work an additional dimension and demands of the students an increasingly integrative ability to think and design.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>It is a must to take part in the introduction course.</td>
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<tr>
<td>Time and place:</td>
<td><a href="http://www.buk.arch.ethz.ch/Lehre/Einfuehrungsveranstaltung">http://www.buk.arch.ethz.ch/Lehre/Einfuehrungsveranstaltung</a></td>
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</tbody>
</table>

### Major Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0366-00L</td>
<td>The Architecture of the City from Modernity to Today</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>V. Magnago Lampugnani</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture covers the time of the 20th century and describes with theories, projects and implemented plannings the history of the modern city. The lectures emphasizes on the historical plannings and methods and presents each specific urban development within a broader context.</td>
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<tr>
<td>Objective</td>
<td>This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.</td>
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</tbody>
</table>
The lecture notes for the course "Building Process: Economy" are available online at the following link:

http://www.bauoek-modell.ethz.ch

Enrolments of students not showing up on 17.9.15 are deleted without delay.

The course "History of Art and Architecture V: Buildings for Books" requires students to demonstrate an understanding of the architectural history of libraries from the Renaissance until now and focuses on such and other questions.

Further recommended literature to consult is listed within the script.
While contemporary education in the field of building construction clearly emphasizes new building, architects future tasks will shift increasingly towards the existing stock. Knowledge about methods of historic construction is indispensable for any measures in the building stock. Therefore we launch an introduction into vital areas of historic construction and building techniques.

Facing analytical tasks in the context of historical constructions, the students shall gain a general overview of the themes of historic building construction (construction processes, quality assurance intervening in historical buildings, typical problems and solution possibilities, standardization and scaling, methods of analysis and evaluation of the building stock).

Focus topics will be:
- Pre-industrial building construction and 19th century (IDB)
- Concepts and theory of construction in history of building engineering (Jürg Conzett)

**063-0371-15L**  
**Project studio: Building and Conservation**  
W  4 credits  3U  H. Hassler

The project studio "Building and Conservation" offers a research-oriented subject for the Master program. Building research and historic building construction form the basis of the project studio. Through analyzing constructions and imparting contextual knowledge students will be enabled to meet challenges of building within existing structures. Questions on historical development of objects and theories, analytics of material and methods of repair will frame the discourse. During the autumn semester 2014 the project studio will be focussing on the the main building of the ETH Zurich.

**063-0417-15L**  
**Architecture and Structure**  
W  2 credits  2G  J. Schwartz

The focus is on structural and statical issues with respect to realization. Exemplary buildings are analyzed using graphic statics and specific properties of different materials discussed. The course is centered around a design exercise where the form should be the result of a structural design implemented in an architectural design, combined with a deep knowledge of architectural space.

Understanding of structural design as translation of structural concepts into building materials with respect to design concepts.

**063-0419-15L**  
**Experimental Explorations on Space and Structure**  
W  3 credits  3S  J. Schwartz.

J. J. Castellón González,  P. D’Acunto

Introduction into an experimental approach to architectural design based on the application of methods that integrate structural and spatial parameters.

Basic understanding of the experimentation with design methods in architecture. Ability to build up models throughout digital and physical exploration integrating space and structure.

In recent decades, new methodologies have emerged in architectural design that exploit the implementation of different parameters as generators of the design concept. Building on the programmatic idea of the Chair of Structural Design of reconciliation of the disciplines of engineering and architecture, the course experiments with the application of design methods that integrate structural and spatial principles from the early stages of the design process. These methods are based on simple geometrical rules that relate spatial and structural parameters. The experimental process will be carried out through the development and construction of physical and digital models. This will allow for the exploration of the permeability of the boundary between the physical and the digital realm.

Enrolment on agreement with the lecturer only.

**063-1357-15L**  
**Digital Urban Simulation**  
W  4 credits  4G  R. König

In this teaching unit architectural and urban design are analyzed by current computational methods. Based on these analyses the effects of problems can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of these correspondent methods in early planning phases.

The students learn how the design and planning of cities can be evidence based by using scientific methods. The teaching unit convey knowledge in state-of-the-art and emerging spatial analysis and simulation methods and equip students with skills in modern software systems. The course consists of lectures, associated exercises and workshops, as well as of one integral project work.

In a series of theory lectures we explore how the design and planning of cities can be evidence based using scientific methods. By various exercises the students are equipped with skills in modern software systems. In an integral project work knowledge in state-of-the-art and emerging spatial analysis and simulation methods is deepened. Based on the imparted methods the effects of planning and design interventions can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of these correspondent methods in the early planning phases.

051-0515-15L  
**Building Physics IV: Urban Physics**  

Urban physics: wind, wind comfort, pollutant dispersion, natural ventilation, driving rain, heat islands, climate change and weather conditions, urban acoustics and energy use in the urban context.

- Basic knowledge of the global and the local microclimate around buildings
- Impact of urban environment on wind, ventilation, rain, pollutants, acoustics and energy, and their relation to comfort, durability, air quality and energy demand
- Application of urban physics concepts in urban design
- Climate Change. The Global Picture: global energy balance, global climate models, the IPCC process. Towards regional climate scenarios: role of spatial resolution, overview of approaches, hydrostatic RCMS, cloud-resolving RCMS.
- Urban micro climate and comfort: urban heat island effect, wind flow and radiation in the built environment, convective heat transport modelling, heat balance and ventilation of urban spaces - impact of morphology, outdoor wind comfort, outdoor thermal comfort, urban energy and urban design. Energy performance of building quarters and cities, decentralized urban energy production and storage technologies, district heating networks, optimization of energy consumption at district level, effect of the micro climate, urban heat islands, and climate change on the energy performance of buildings and building blocks.
- Wind driving rain (WDR): WDR phenomena, WDR experimental and modeling, wind blocking effect, applications and moisture durability
- Pollutant dispersion, pollutant cycle: emission, transport and deposition, air quality
- Urban acoustics. Noise propagation through the urban environment, meteorological effects, urban acoustic modeling, noise reduction measures, urban vegetation

All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/)

**066-0427-00L**  
**Design and Building Process MBS**  
W  2 credits  2V  A. Paulus

Lectures on twelve compact aspects gaining importance in a increasingly specialised, complex and international surrounding: Topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade and getting started.

"Design and Building Process MBS" is a brief manual covering the competencies and the responsibilities of all involved parties through the design and building process. Lectures on the topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship.

All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/)

No prior knowledge is required.
Content “Design and Building Process MBS” is a brief manual covering the competencies and the responsibilities of involved parties through the design and building process. Twelve compact aspects regarding the establish building culture are gaining importance in an increasingly specialised, complex and international surrounding. Lectures on the topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade, and getting started will guide the participants, bringing the individual pieces of knowledge to a superordinate relationship. The course introduces the key figures, depicts the measurable and non-measurable criteria of the project and highlights the provided services of the consultants. In addition to discussing the basics, the terminologies and the tendencies of the lecture units will refer to the studios as well as the practice: Teaching-based case studies will compliment and deepen the understanding of the twelve selected aspects. The course is presented as a moderated seminar to allow students the opportunity for individual input: active collaboration between the students and their tutor therefore required.

063-0311-15L Transitional Periods: Swiss Renaissance and Baroque W 1 credit 1V M. Gnehm

Abstract The lecture discusses the striking presence of hybrid forms in Swiss architecture of the 16th to the 18th centuries by means of secular and religious buildings from all parts of Switzerland.

Objective The objective of the lecture is to understand peculiarities of Swiss Renaissance and Baroque architecture in its relation to diverse social contexts and cultural changes.

Content Swiss architecture of the 16th to the 18th centuries often defies stylistic classifications under the headings of Renaissance and Baroque. The notion of “hybrid style” was applied, meaning e.g. the blending of Gothic and antique elements, and 17th-century buildings were ascribed to the Renaissance. All these features were termed as “stylistic belatedness” and explained as arising from the political situation of Switzerland as a “borderland” (divided also in itself) that intended to preserve elements of its own against foreign forces. In revising opinions like these, the lecture discusses by means of the analysis of single buildings and their context (amongst others the Hôtel de Ville in Geneva, the cathedral of Lugano, the Maison des Halles in Neuchâtel, the Stockalper Palace in Brig, the orphanage in Zurich or the Abbey church of St Gall) the qualities of hybrid forms and anachronisms (to be found also in the surrounding Europe) as an expression of the will to accommodate cultural changes.

063-0363-00L Urban History Online. Methods for Text and Plan W 2 credits 2U

Analysis

Abstract In obtaining the necessary knowledge and understanding of historical complexities, this in-depth course will give you at hand critical and analytical as well as strategic and planning skills. The course exists of three learning blocks (e-learning), which are embedded in an interactive learning environment, which have to be completed within a given time period.

Objective The topic of the course is the history of the architecture of the city. In addition to the above-mentioned skills, you will be reflecting on continuities, which are to be found at different times in the urban history. All competences, which are to be taught in this course will be exemplified in urban case studies, i.e. plans, photos, models, and in theoretical treatises. If you are inscribed into the lecture «The history of the city from modernity until today» you will enhance your skills in creating a mental model, where with the help of especially developed learn activities (e-learning) you will understand, handle, reproduce and even widen your methodical competences. If you are solely attending the in-depth course you will immerse in the basic knowledge of the history of urban design and learn fundamental methods of analysing of texts and plans. The time of this examination can be chosen within a given time period.

Content The content of the course emphasizes on the profound discussion and examination of interrelations of selected, exemplary urban theories and projects thought and built in the 20th century. Within three conceptually designed learning blocks (e-learning) you will develop and train basal methods of analysing of texts and plans. The time of this examination can be chosen within a given time period.

051-0317-15L History of Art and Architecture: Situating Climate Change W 4 credits 3G E. E. Scott

Abstract This seminar explores the admittedly vast topic of global climate change by way of case studies that link specific sites with its various facets—ecological, legal, infrastructural, etc. It aims to offer entry points into a defining phenomenon of our age, one that moreover carries direct implications for architecture at the scale of territorial thinking/planning down to individual building design.

Objective Students should come away with broadened, interdisciplinary knowledge of climate change as a phenomenon that is at once environmental and social, and unfolds at both planetary and highly local scales. They will also be pushed to examine its implications for architecture, including beyond purely technological or infrastructural considerations.

Content This seminar explores the admittedly vast topic of global climate change, with the aim of rendering it simultaneously less abstract and more complex. As a phenomenon, climate change is dizzyingly convoluted, entailing many things happening in many places at once, at varying rates and scales, and with myriad types and degrees of consequence.

The course is structured by way of individual case studies (one per week) that connect specific sites with specific facets of climate change—ecological, economic, legal, and so on. One week, for example, will focus on the Arctic Ocean as a geopolitical hotspot where countries are currently vying to stake claims on pathways for international shipping and oil exploration opened by melting ice. Other weeks will consider, among additional scenarios: a Swiss Valley with melting glacier and its infrastructural repercussions; the Maldives as a disappearing nation state relative to Rob Nixon’s notion of “slow violence”; the upcoming COP meeting in Paris as a key site where climate-related policy is forged; and the atmosphere itself as a dynamic, planetary-scale “geography.”

As a whole, the seminar aims to offer new entry points into a defining phenomenon of our age, one that moreover carries direct implications for architecture at the scale of territorial thinking/planning down to individual building design.

Lecture notes

A syllabus, required readings, and other course materials will be published/downloadable from the website of Professor Ursprung’s chair at the beginning of the semester.

Prerequisites / notice

The three blocks of the course are related to the lecture «The history of the architecture of the city». The course can be attended in two modes, either in combination with the above-mentioned lecture or independently as a single course. The entire course is held in german.

063-0623-15L Zurich from the Outside (a Map of Metropolitan Territory, Field Trips) W 2 credits 4U M. Topalovic

Abstract Talk about and devise architectonic ways of perceiving, studying and portraying urban territories that lay beyond the limits of the city.
## Electives

### Architecture / Design

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>051-0169-15L</td>
<td>Seminar Architectural Criticism: The City and the Architectural Property</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>C. Schärer</td>
</tr>
<tr>
<td>051-0173-15L</td>
<td>Spatial Concepts in Film and Architecture (Prof A. Gigon/M. Gwyer)</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>D. E. Agotai Schmid, M. Bächtiger Zwicky</td>
</tr>
<tr>
<td>051-0193-15L</td>
<td>Performance and Intervention</td>
<td>W</td>
<td>2</td>
<td>2U</td>
<td>S. Keller Roca</td>
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<tr>
<td>051-0195-15L</td>
<td>Criticism and Theory</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>K. Sander</td>
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<tr>
<td>051-0197-15L</td>
<td>Photography</td>
<td>W</td>
<td>2</td>
<td>2U</td>
<td>K. Sander</td>
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<tr>
<td>051-0199-15L</td>
<td>Architecture and Photography</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>T. Wootton</td>
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<tr>
<td>051-0201-15L</td>
<td>3D Scanning and Freeform Modeling</td>
<td>W</td>
<td>2</td>
<td>2U</td>
<td>K. Sander</td>
</tr>
</tbody>
</table>

### Content

**Objective**

The architecture's ways of looking are unstable at territorial scales, and yet, urban territories are crucial contexts of architecture. Seeing and understanding territory as part of the city, its mirror, reflects back in the ways we see the city itself and its architectures. How can architecture extend beyond the limits of the city, into the field? How can architects look at, study and design the "city's constitutive outside:" the periphery; the aggl; the country; the hinterland? What are the motives (aesthetic, political) we can have in these territories? What is the importance of being there, in the flesh, on-site? How to move in the field, how to discover it? What are the visual and narrative strategies that can capture the character of territory and its sites?

**Content**

Weekly studio exercises and on-site expeditions. (The product of the weekly exercises are shown in a common booklet that will serves as a portrait, or a "map" of the chosen urban territory in Switzerland. The character of the work is positioned between architecture, urbanism and visual arts.)
Objective
The department of Architecture and Fine Arts has a 3D-Bodyscanner available for the digitalization of persons and objects, and is complemented by a special software for modeling the 3D data. After a period of training and practice, participants are asked to develop ideas and concepts for their own projects. These concepts should be used to lead and expand the system and the possibilities of its application. The process of readjustment and its realization will be a continual part of developing the individual projects.

Prerequisites / notice
The number of participants is limited to 14 students and enrolments need the lecturer's allowance! We Works with a 3D Touch Mouse, see Youtube https://www.youtube.com/watch?v=NF7nfktef2Q

Proficiency in Windows systems is a precondition for participation. To enroll in the course, please consult the lecturer: Adi Grüninger: grueninger@arch.ethz.ch

051-0219-15L Artistic and Conceptual Thinking and Working

Objective
This seminar aims at providing access to the prelinguistic space of artistic thinking and agency, in order to be able to observe the artists in their immediate working process. This space can only be entered if we successfully leave all layers of mediation behind us and cease to force an understanding.

Literature

Prerequisites / notice
Application for the course with the lecuturer also via e-mail: stefan.keller@arch.ethz.ch

051-0223-15L Free Drawing

Objective
Drawing is used to ascertain and develop the artistic ideas and abilities of students. Different techniques and methods will be tested. Development of individual expression in the realm of drawing; artistic flexibility and skill in the areas of working strategy and aesthetic impact.

Literature

Prerequisites / notice
Application for the course with the lecuturer also via e-mail: Zilla Leutenegger <leutenegger@arch.ethz.ch>

051-0227-15L Architectural Drawing

Objective
Based on the process of the concrete, practical drawing, we can sensitize our perception and enhance also the interaction between head and hand. Also the digital drawing with iPad and Wacom tablet (if available) should not be missed out as an additional challenge. The second hour of lecture is booked for the review of the weekly exercises.

Prerequisites / notice
The number of participants is limited.

051-0235-15L Theory of Architecture (Seminar)

Objective
We will approach the prelinguistic space of artistic thinking and agency from its context, which supports, mediates, criticizes, sells and preserves its productions - the artworks. We will listen to the various protagonists of this space - cultural agents in civil service institutions, art mediators, critics, curators, gallerists, custodians; for in this space surrounding the prelinguistic one, nothing is left to chance.

Prerequisites / notice
The number of participants is limited. Application for the course with the lecuturer also via e-mail: Leutenegger@arch.ethz.ch

051-0621-15L Architecture and Digital Fabrication: Graded Structures

Objective
Advance in technology revolutionizes design and fabrication processes within architecture. Digital fabrication allows immediate production from design data. The architect as author of these data takes a key role in this development. This course focuses on strategies for architectural production by means of algorithmic design tools and computer controlled fabrication methods.

Lecture notes
The script is provided by the teaching chair and can be purchased the day the elective course starts. Limited places (enrolment on lecturer's acceptance only).

051-0819-15L Planning Strategies for Complex Buildings Using the Example of Health Facilities

Objective
The objective is that the students engage in a debate of a differentiated functional planning as a basis for complex buildings which are to be successful functionally, operationally and in design. On the basis of a given scope of themes the students carry out research aiming for possible improvements for example in health facility planning. The scope of subjects is announced at the beginning of each semester.

Data: 06.12.2018 13:04 Autumn Semester 2015 Page 75 of 1432
Complex buildings such as health care buildings are subject to constant change. In a new hospital building 60% of the diagnostic and treatment areas are subject to building changes within the first 10 years of operation. Architecture has to develop concepts which accommodate this level of dynamics into the building structure in a better way. In the coming years this need for adaptability is going to be challenges even further by the even more reducing health care resources. The paper should discuss in this context a specific question in detail by analysing problems and developing and discussing potential planning solutions.

Building Physics: Moisture and Durability

The aim of this course is to apply caad tools to design problem solving. By creating solutions to a given task, the course explores the use of the computer in different phases of the design, from analysis to presentation. Even at the stage of the analysis, network and the multimedia possibilities are important. Interactive design evolves from interactive 2d sketching, scanning, image processing, and 3d Modeling. Plotting, rendering, animation, and rapid prototyping are the main focus in the area of presentation. This course does not overlap with the diploma application on 3 emblematic case study buildings will be discussed.

The employment of computers in architecture becomes ever more pervasive; the hardware less expensive, the software easier. In this course practices are comunicated beyond the routines of conventional, commercial software systems. CAAD theory examines mutual dependence of programming methods and architectural sketching in the practical experiment. The elective course consists of lectures, exercises and an individual final work.

The aim of this course is to apply caad tools to design problem solving. By creating solutions to a given task, the course explores the use of the computer in different phases of the design, from analysis to presentation. Even at the stage of the analysis, network and the multimedia possibilities are important. Interactive design evolves from interactive 2d sketching, scanning, image processing, and 3d Modeling. Plotting, rendering, animation, and rapid prototyping are the main focus in the area of presentation. This course does not overlap with the diploma elective caad computer-aided architectural design, but instead, it demonstrates a deepened application of the principles involved in design. The students do need knowledge of the basic principles, which they can acquire during the winter semester course, caad computer-aided architectural design.

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Three buildings case study will be presented. Different certification schemes, including LEED (American standard), DGNB (German Standard with Swiss adaptation), SNBS, MINERGIE-ECO and 2000-Watt-Society (Swiss standards) will be presented and explained by experts.

After this overall general presentation and in order to have a closer look to specific aspects of sustainability, students will work in groups and assess during one or two weeks this specific criteria on one of the case studies presented before. This practical hands on the label will end with a presentation and a discussion where we will highlight differences between the labels.

This alternation of working session on one specific criteria for one specific building followed by a group presentation and discussion to end with a presentation and a discussion where we will highlight differences between the labels.

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Objective
- Basic knowledge of moisture transport and related degradation processes in building and civil engineering materials and structures
- Introduction to concepts of poromechanics and multiscale analysis
- Application of knowledge by the analysis of damage cases

Content
1. Introduction
   Moisture damage: problem statement
   Durability

2. Moisture Transport
   Description of moisture transport
   Determination of moisture transport properties
   Hysteresis
   Transport in cracked materials
   Damage and moisture transport in cracked media

3. Poromechanics
   Moisture and mechanics: poro-elasticity
   Poro-elasticity and salt crystallisation
   Poro-elasticity and damage
   Case studies

4. Multiscale analysis
   Problem statement
   Multiscale transport model
   Multiscale coupled transport - damage model

**051-0415-15L Negotiating Structural Forms: History of Structural Design**
- W 2 credits 2G
- J. Schwartz, M. Rinke

**Abstract**
Dealing with the structural necessity against the background of the formal intent often lead, besides discourses, to architectural and technical enrichment as well as unique buildings. This seminar focuses on the work of key figures, that will be discussed on the basis of texts, concepts and buildings.

**Objective**
Getting to know key designers on the borderline between architecture and structural engineering, their positions, concepts and most important buildings.

**Content**
Seminars focusing on the discussion of important essays and buildings of distinguished builders and architects on the basis of short presentations, models, input lectures and invited guests, as well as films and excursions.

**051-0763-15L New Focal Points of Construction**
- W 2 credits 2G
- D. Mettler, D. Studer

**Abstract**
The elective subject "New focal points of construction" investigates the complex interaction of construction elements by means of exemplary architectonic tender points such as base, wall, chamber, roof etc.

**Objective**
The comparative analysis of built constructions serves as a basis for further development of hypothetical future constructions.

**Content**

1. Comparative analysis for derivation and understanding of the constructive points base, wall, chamber, roof etc.
2. Description of current level of technique, typical methods, and set of problems.
3. Final colloquiums with guests of producing and processing companies.

**Exercise:**
New formulation of a future konstructive point as a result of a diagnostic work.

**051-0777-15L Building Process: Realization**
- W 2 credits 2G
- M. W. Eglin

**Abstract**
Visits to construction sites and interdisciplinary lectures on the topics of communication, complexity, landscape and investment are the main focus of the workshop. In addition, the term process is to be depicted by means of visits to manufacturers of construction components.

**Objective**
The main focus of the diploma elective subject is in showing the building process by means of current examples of urban design with architectural relevance. The Chair views itself as the facilitator between those involved in construction and students. Active participation is a prerequisite.

**Content**
The main focus of the diploma elective subject is in showing the building process by means of current examples of urban design with architectural relevance. Visits to construction sites and interdisciplinary lectures on the topics of communication, complexity, landscape and investment are the main focus of the workshop. In addition, the term process is to be depicted by means of visits to manufacturers of construction components. The Chair views itself as the facilitator between those involved in construction and students. Active participation is a prerequisite.

**Literature**
Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009

**Prerequisites / notice**
The number of participants is limited and enrolment is only possible in agreement with the chair.

**051-0781-15L Costruire correttamente/Constructing Correctly:**
- W 2 credits 2G
- G. Birindelli

**Curved Bearing and Folded Bearing Structures**
Abstract
In line with the approach of P.L. Nervi's book, our study is based on factors that, outlined by him, are still today all the more relevant as a lesson for architecturally and structurally justified buildings. We will observe selected buildings both of our time and of the past for their space, architecture and construction, understand them and interpret them according to universal values of design.

Objective
'Truestruire correttamente' (Constructing Correctly), the 1955 book published by Pier Luigi Nervi, covers crucial factors for building that, outlined by him, are still today all the more relevant as a lesson for architecturally and structurally justified buildings. His thoughts represent valuable criteria and indispensable tools for observation and carrying out investigations of the built environment.

Lessons learned from this can enrich the design work of today's and tomorrow's architects.

All of these (see abstract) i.e. analyses, observations, hypotheses, groupings and cross-comparisons, will help the students in their careers to find their own strategies and approaches to design and to be aware of them. And so, according to the advice of Pier Luigi Nervi: "...At every stage of his training, the future architect should be constantly and methodically guided to search for essential elements in each problem, be it large or small. The study of the architectural works of the past should consist in the critical examination of their functional and structural solutions and of the relation between these and form, in order to show that form is a consequence and not a determinant of functional and structural needs." [P.L. Nervi: Costruire correttamente, Milano 1955; English version titled "Structures", 1956, p.28].

Content
The main thread of this course, that runs over two semesters (*), are buildings of all ages that could be categorised under notions such as «most viewed», «most technically daring», «most unknown», «most discussed» or «most worthy of discussion», and carry instructive aspects of the teachings of Pier Luigi Nervi ("costruire correttamente"). In the lecture, these buildings will be investigated on-the-spot, described from the designers' point-of-view and will be commented on with reference to any redesign resulting from the interplay of architectural and structural concepts. Harmonies and discord should be discovered.

Occasionally there will be guest lectures. These people, who were directly involved with a certain building, will portray the emergence and development of the project.

In this sense, the course is also intended for civil / structural engineering students and presents a possible bridge between the two prospective project partners - architect and engineer.

Lecture notes
None for the time being

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course title</th>
<th>Credits</th>
<th>Seminar</th>
<th>Lecturer</th>
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<tr>
<td>051-0855-15L</td>
<td>Masterclass Construction: Brickwork</td>
<td>2</td>
<td>W</td>
<td>C. Vogt</td>
</tr>
<tr>
<td>Abstract</td>
<td>The Meisterkurs Konstruktion is seeking a critical discussion on relevant constructive (and energetic) questions of our time. Alternating each semester, one of the typical construction methods will be examined: masonry, concrete, steel, woodwork and curtain wall facades. In the autumn semester 2015 we will focus on contemporary brickwork constructions.</td>
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<tr>
<td>Objective</td>
<td>The prospective architect shall develop necessary skills to be able to think construction in its complex relationships and to face future discussions in practice competently.</td>
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<tr>
<td>Content</td>
<td>The structure of the course contains: 1. Impartation of basic knowledge of construction 2. Seminar / exercises on the state of technology / research 3. Integration of practical case studies and problems</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Enrolment on agreement with lecturer only.</td>
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<tr>
<td>051-0823-15L</td>
<td>Material-Workshop</td>
<td>3</td>
<td>W</td>
<td>A. Spiro</td>
</tr>
<tr>
<td>Abstract</td>
<td>The elective is organised as a laboratory where one particular material will be explored on a theoretical and practical level. During this study the contemporary architectural potential of the material will be tested and applied.</td>
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<tr>
<td>Objective</td>
<td>The objective of this course aims at exploring the correlation between material, construction and architectural expression.</td>
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<td>Prerequisites / notice</td>
<td>Enrolment on agreement with lecturer only.</td>
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<tr>
<td>051-1219-15L</td>
<td>Integrated Discipline Building Systems (A. Schlüter)</td>
<td>3</td>
<td>W</td>
<td>A. Schlüter</td>
</tr>
<tr>
<td>Abstract</td>
<td>The integrated discipline Building Systems addresses specific questions about building systems and system concepts. Energetic analysis and system designs are carried out on the students individual design projects.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The course aims for an ability to understand concepts of sustainable building technology coherently integrated into an architectural design. The focus lies on LowEx-systems.</td>
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<tr>
<td>101-0577-00L</td>
<td>An Introduction to Sustainable Development in the Built Environment</td>
<td>3</td>
<td>W</td>
<td>G. Habert</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course was offered as &quot;Sustainable Construction&quot; until HS14. This year the UN Conference in Paris will shape future world objectives to tackle climate change.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>This course provides an introduction to the notion of sustainable development when applied to our built environment.</td>
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</tbody>
</table>

The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

### Planning / Environmental Design

#### Number

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>051-0627-15L</td>
<td>Topology: Decomposing Röntgenplatz in Zurich (Ch.Girot)</td>
<td>W</td>
<td>2 credits</td>
<td>2K</td>
<td>C. Girot</td>
</tr>
</tbody>
</table>

#### Objective

- The focus of the seminar is to understand the urban history of Zurich through selected case studies.
- The aim of the seminar is to discuss the selected Zurich case studies against the background of the history of urban design.
- The City of Zurich rises there where Celtic tribes settled and the Romans founded a the city. In the past two millennia authorities, planners of different discipines, merchants and craftsmen, institutions and investors have shaped the city upon the Limmat. The physical outcome of these interventions stand in close relationship with the knowledge of the time and reflect the prevailing positions and theories, which were thought, published and built elsewhere. For that matter, the history of urban design of Zurich can be well understood as a branch of the history of European urban design, as well as the individual steps of development are offsprings of international reflexions and tendencies. Presentations in the seminar room and the visit of the selected ensembles in Zurich will help to tell the story of the urban development from the Middle Ages up to today. With this basic knowledge gained in the seminar and the walks the students will have to discuss the historical theories and developments as well as the urban qualities of the ensembles. This will help the students not only to better understand the city but will also allow them to sample different urban situations and gather spatial experiences, which can also facilitate their design process.

- How can the use of multimedia tools encourage the development of new and different viewpoints on landscape? A mix of digital tools will help us develop our field of experimentation in landscape. We will analyse the structure of these places and develop new theses on the contemporary perception and use of landscape.

- The glaciers formed the landscape we live in and remain a central element in our perception of the Swiss Alps - as 'wild' nature, aesthetic experience and natural resource - and soon may be gone forever.

- We will investigate one remaining but slowly disappearing glacier and come in direct contact with the ice. We want to search for traces of movement and time, using two approaches: First, we will take pictures with an analog large-format photo camera. Second, we will record sounds with contact microphones to finally create an audio-visual experience from our own perception of this landscape.

- The number of participants is limited to 24 persons.
- Number of participants limited (limitation due to technical equipment).
- Course language: English or German (number of participants is limited!)

#### Course time

- Course language: English or German (number of participants is limited!)

#### Literature

- A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.
- All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.
The term ‘paradise’ and its religious implications originate from ‘pairi-daeza’, Old Persian for ‘a wall surrounding a garden’. Pairi-daeza is the title of an elective course addressing basic elements of landscape architecture. This semester, students will deal with the topic ‘Threshold’, developing a design for a metropolitan park in Lyon.

The course is limited to 24 students. The restriction follows the time of the inscription. In order to enroll in the course, students must participate in a two-days trip to Lyon on the weekend of 3/4.10. The contribution to expenses will be 200.- CHF.

Enrolment after Agreement only!

Objective
The objective is to gain a deeper understanding of topics and methods of urban design and urban research. Specific knowledge about relation and various processes in cities and countrysides, with regard to production, handling, logistics, consumption habits and disposal of foodstuff. The production, processing, distribution, consumption, and disposal of food have perpetually affected the relationship between city and countryside. In that sense, the industrialization and globalization of food systems contributed to the urbanization of the landscape. On the other hand, logistic systems and consumer behavior are strongly affected by processes of urbanization, which shows that the city and its food system have a mutual influence on each other.

Prerequisites / notice
The course is accompanied by a workbook with texts and background information.

051-0631-15L
Urban Food
Limited number of participants. Enrolment in agreement with the lecturer only.

Objective
Specific knowledge about relation and various processes in cities and countrysides, with regard to production, handling, logistics, consumption habits and disposal of foodstuff.

Content
The production, processing, distribution, consumption, and disposal of food have perpetually affected the relationship between city and countryside. In that sense, the industrialization and globalization of food systems contributed to the urbanization of the landscape. On the other hand, logistic systems and consumer behavior are strongly affected by processes of urbanization, which shows that the city and its food system have a mutual influence on each other.

051-0667-15L
Case Studies in Urban Design: Office Parks - A Global Typology

Objective
Case studies in urban design address specific themes in urban design and spatial development.

Prerequisites / notice
Enrolment after Agreement only!

051-0701-15L

Objective
The seminar will focus on case studies in order to reveal strategies for dealing with the modern city. Built urban-development ensembles from the twentieth century will be embedded in their architectural and historical context, studied with an eye to their constitutive elements and discussed in connection with current urban-planning projects. In addition to various forms of methodological engagement with urban contexts, students will experience how the disciplines of urban-planning history and urban development can be considered in a more integrated way. Moreover, they will receive feedback on how to present the result of their analyses in concise, well-structured talks and in drawings.

Content
The approach to urban-planning ensembles of the twentieth-century city is characterized by their enormous quantity - which also makes dealing with them more difficult. The building stock dating from this era is immense. There is little discussion currently of how larger spatial contexts - housing estates, neighbourhoods, entire cities - can be not just designed and planned but also continuously developed as overall ensembles. Moreover, strategies, instruments and procedures for dealing with the vestiges of twentieth-century urban planning have yet to be established. In the seminar we will discuss specific approaches to analysing, assessing and further developing of specific case studies have been formulated and explored recently as well as the extent to which they are experimental and deviate from traditional means for preserving and developing the city. Any discussion of an example of urban planning from the previous century must begin with precise analysis: taking up its original urban-planning principles in their historical dimension and all of the features that affect urban planning. The seminar will emphasise this sort of contextual discussion of modern urban space.

Prerequisites / notice
Enrolment after Agreement only!

051-0722-15L
Information Architecture and Future Cities: Smart Cities
Limited number of participants. Enrolment in agreement with the lecturer only.

Objective
Students gain insight into the next generation of design processes for architects and urban designers, and into concepts of the Information Architecture of SMART CITIES, including the influence of Big Data. They learn about the expanded roles of information and architecture: information and simulation in architecture as means to make the invisible visible, and architecture as a metaphor and ordering system to structure the immense amounts of data of the Information Society. The seminar is highly interactive and discusses visionary case studies in Europe and Asia and new techniques in Big Data informed smart urban design. Apart from learning about and experiencing Information Architecture and SMART CITIES, the course also introduces research and management skills that will distinguish the future ETH architect.

Content
SMART CITIES - What will happen when cities change from static configurations into responsive and dynamic structures? What does it mean for buildings that undergo the same changes? What is the impact on architectural and urban design education? How can citizens influence this development? The SMART CITIES course will answer these questions and supply you with the necessary skills and knowledge to understand and design such dynamic structures. The intelligent use of data and information are at the core of this course. Data and information are new building materials of future cities. Citizens produce increasing amounts of data in their daily life, with stationary sensors and mobile smartphones. Using those data, citizens begin to influence the design of future cities and the re-design of existing ones. The course will be a first step towards the emerging citizen design science and cognitive design computing. Those will be the next generation of participatory design and design computing.

Lecture notes
iBook INFORMATION CITIES
The necessary texts will be found on the Chair's website at: http://www.ia.arch.ethz.ch. We specifically recommend the consultation of the Future Cities Website at: http://www.futurecities.ethz.ch during the entire course. The iBook INFORMATION CITIES is available in the iBooks Store for free.

Interactive seminar including 3 exercises

**051-0725-15L**  
**Digital Urban Visualization. People as Flows**  
W 2 credits 2U G. Schmitt

**Abstract**  
We examine patterns of crowd-flows in an extraordinary urbanisation phenomena: festivals.

**Objective**  
The course participants will learn how to program simulations using Processing/Java. Previous programming knowledge is not necessary. Furthermore they will gain insights into other analysis methods and learn about their significance, strengths and weaknesses.

**Content**  
We will look at those patterns from two sides. One being the view of a planer asking to find bottle necks or the ideal place for amenities such as booths, toilets etc. Another being the view of visitors. We will program different behaviours that should compete against each other in order to compare their different strategies. As a case study we will use the Caliente Festival in Zurich.

For deepening the learnt in a semester thesis we offer to optimise the created simulations to make them available in interactive planning workshops. Additionally they could be converted into interactive web apps.

http://www.ia.arch.ethz.ch

No programming skills are required.

**051-0815-15L**  
**ACTION! On the real City - Play, Negociate and Act!**  
W 2 credits 2U A. Brillembourg, H. Klumpner

**Abstract**  
The elective course "Action! On the City" will focus on developing a board game that facilitates the decision-making and design processes to answer complex, real-life urban transformations. The course aims to explore the requisites for a sustainable urban development through the lens of various disciplines, such as architecture, engineering, and environmental sciences.

**Objective**  
The tasks consist of both individual and group work: data collection; definition of game components (such as actors, rules, events, etc.); identification of specific variables (such as land value, land use, density, mobility, social structure, etc.); and evaluation of outcomes into concrete design solutions.

By developing this board game, students will learn how to articulate decisions, to facilitate negotiations, and to define common visions in a trans-disciplinary framework. The course will teach both systematic and creative approaches, strengthening the role of the future planners as moderators for an integrated city development.

It is available for students from all disciplines.

Lecturers: Marie Grob, Lea Rüfenacht, Gianmaria Socci

**051-0821-15L**  
**Summer School: Markets in the Tropics - Barranquilla**  
W 4 credits 4G H. Klumpner, A. Brillembourg, M. Staffacker

**Abstract**  
This summer school will function as an inter-disciplinary think-tank, exploring the requisites for sustainable urban development in Barranquilla through the lens of architecture, engineering, and environmental sciences. You will be challenged to work in an intensive cross-cultural setting and develop solutions in a complex, real-life context with local practitioners and stakeholders.

You will receive full support on-site from Universidad del Norte and ETH tutors from your discipline. In developing the scenarios you will work side by side with young professionals with a grounded knowledge of the field, and be joined by a wide variety of local stakeholders.

The program will combine site visits, expert lectures and workshops to allow you to develop the following skills:

- The capacity to work to address urban challenges in an inter-disciplinary team
- Apply Scenario Analysis technique to structure and integrate knowledge from various fields
- Cross cultural understanding and skills in an international collaboration
- Mechanisms to collaborate and communicate with practitioners and stakeholders
- Understanding of integrated and sustainable urban development
- Ability to use stakeholder participation to solve real world problems
- Are these boomtowns doomed to follow the fate of megacities or will they successfully avoid the pitfalls of rapid urban development? This program is part of a three-year ambitious collaboration with the Inter American Development Bank’s Emerging and Sustainable Cities Initiative and the Swiss Ministry for Economic Cooperation (SECO). It will influence decision makers and engage with real issues.

ETH is teaming up with the leading Universidad del Norte in Colombia to focus on Barranquilla, a rapidly growing city of 1.2 million inhabitants on the Atlantic coast of Colombia. Following a period of decline, vast sums of foreign investment are now flowing into this port city, with the potential to reverse current inequalities and spark more sustainable development.

In a team, you will produce alternative urban scenarios for the redevelopment of Barranquillas Central Market. You will contribute your expertise and unpack the realities of sustainable development in a tropical climate. How can knowledge from the ETH be combined with leading Colombian research and translated to a Latin American context? Through debate, controversy and collaboration it is expected you produce scenarios that integrate your different disciplines and question the preconceptions of sustainable urban development.

This immersive summer school will be structured in three interlocking modules:

- In the first module you will investigate the central market and gain a strong understanding of the social, environmental and built context in Barranquilla. You will employ and combine your varied disciplinary methodologies to gain insight into the sustainability challenges facing the city and the redevelopment of the avenue.
- In the second module, you will develop a series of scenarios for the central market in Barranquilla, proposing alternatives for its sustainable future. You will build on research from the first module, and explore the potential of your ideas with local stakeholders and professionals from your field. You will document these scenarios using creative and varied representational methods.
- In the final module you will pitch your scenarios to decision makers. During this high-level event you will measure their preferences, debate the associated trade-offs, and provide a series of orientations for those planning the future of Barranquilla.

More information on our blog: www.marketsinthetropics.com
Prerequisites / notice

Who should apply?
Enthusiastic students currently enrolled in a masters program in ETH Zurich and Universidad del Norte, Barranquilla Colombia. A balanced group of 12 ETH master students from the D-ARCH, D-USYS and D-BAUG departments will be selected. They will be joined by 12 Colombian students from our partner university in Barranquilla, Universidad del Norte.

Applicants should have a strong interest in sustainable urban development and trans disciplinary collaborative research. They should be able to demonstrate their academic strength, motivation, interest and expertise. Knowledge of Spanish is welcomed but not obligatory.

ETH participants will be charged a fee of 300 CHF to cover local activities, travel and accommodation.

Students will be responsible for organising visa, health insurance, and transportation to and from Barranquilla. Flights to Barranquilla from Zurich cost approximately 1700 CHF. Additional travel grants are available for ETH students.

Applications can be submitted including curriculum vitae, portfolio where relevant and letter of motivation as portable document format (pdf) by May 30th, 17:00 CET to hertzog@usys.ethz.ch

Notification for admission June 1st.


Number of participants limited.

Abstract
The programme revolves around the so-far untapped resource desert sand and the question of how to activate its potential as an alternative building material. The E4D winter school will be composed of 30 master and doctoral students of different disciplines related to the topic from ETH Zurich and from other academic institutions. They will be joined by faculty members and external experts.

Objective
The E4D winter school aims to develop an integrated vision to a global challenge of today's construction industry: the non-usability of desert sand. The programme of the E4D Winter School aims at developing alternative methods to activate the so-far unusable resource of desert sand for the construction industry. Lead by different experts from around the world, students will not only learn the theoretic background of this resource but experiment with current and future technologies to transform desert sand. In workshop experiments the acquired knowledge will be tested and applied. The students will attend workshops along three lines of investigation that could mobilise desert sand for construction and other applications: (i) bio-cementation, (ii) sintering and (iii) 3D printing.

Content
Sand is the most used raw material for the production of goods on our planet. It is found in concrete, glass, computers, detergents and even toothpaste. But sand is a finite resource: what took millions of years to come into being through erosion and sedimentation, man is mining at rivers and ocean coasts in a so-far unknown speed. Sand is the megastar of the industrial and digital era - our culture is literally built upon this resource. But sand is not equal to sand: The construction industry requires grain sizes and rough shapes that are only found in river beds, lakes and the oceans. Over the turn of millions of years, mountains gradually eroded into gravel, sand and dust. Eventually, rainfalls carry these particles through existing watercourses to the sea. Sand is mostly composed of quartz, a mineral form of silicon dioxide. It is one of the most abundant materials on the earth surface and also one of the strongest. These properties make it valuable to various industries.

Desert sand on the other hand is presently unsuitable to the construction industry: Gradual wind erosion polishes the sand particles into round and even forms and therefore reduces their friction capacity; desert sand is simply too fine and spherical in shape to act as a high-friction aggregate in a concrete matrix.

Prerequisites / notice
Open for students of all Departments of ETH!

Taking place from 9 to 28 January 2016 at the TU Berlin Campus in El-Gouna, Egypt).

Costs: CHF 500, including board and accommodation. All participants are responsible for organising and financing their own domestic or international travel to El Gouna.

The Engineering for Development (E4D) Winter School 2016 will invite 30 master and doctoral students from different disciplines related to the topic of the winterschool. Applicants will be selected based on their academic record and previous work experiences.

Applicants must send a one-page CV and one-page letter of motivation in PDF format stating their interest, to Mrs. Patricia Heuberger, patricia.heuberger@sl.ethz.ch

Deadline: 30 September 2015
Notification: 20 October 2015


051-0623-15L Travellers. On the Ways of Seeing Urban Territories

(Lectures and Dialogues)

Abstract
Travellers is a series of five lectures and conversations about ways of perceiving, studying and portraying urban territories. Each of the guest speakers is a traveller - a person who places the direct observation and experience of urban landscapes in the core of their practice.

Objective
The architectural ways of looking, concepts and techniques are unstable at large territorial scales, and yet, urban territories can be seen as crucial contexts for the production of architecture. Seeing an extended urban territory as part of the city - its mirror - can reflect back in the ways we see the city itself, and its architectures.

With students and invited guests, we will consider: How can architects look at, study and design urban territories or the "city's constitutive outside": the periphery, the agglomeration, the countryside and the hinterland? What are the motives (aesthetic, political) architects can have in engaging with these territories?

The aim is to discuss concepts and techniques for territorial investigations and projects.
We will be looking at urban territories through the eyes, lenses and concepts of an urban geographer, a cartographer, a photographer, an artist and an architect.

12.10.2015
CHRISTIAN SCHMID
urban sociologist and professor at ETH Zurich
conversation with guests Matthew Gandy, UCL (tbc)

27.10.2015
PHILIPPE REKACEWICZ
journalist and chief cartographer, Le Monde diplomatique
conversation with Marc Angélil and Christian Schmid, ETH Zurich

09.11.2015
BORIS SIEVERTS
artist, Büro für Städtereisen
conversations with Marcel Meili

30.11.2015
AGLAIA KONRAD
artist photographer and videographer
conversation with Bas Princen

31.11.2015
MILICA TOPALOVIC
architect, assistant professor at ETH Zurich
5.15pm Inaugural lecture at ETH Zentrum HG, Audi Max F30

Lecture notes
Mon, 5.30 - 7 pm, ONA Focushalle

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<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>051-0171-15L</td>
<td>History, Criticism and Theory of Architecture:</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>L. Stalder</td>
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<td></td>
<td>Architectural Machines V</td>
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<td>Not eligible as a Compulsory GESS Elective for students of D-ARCH.</td>
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<td>051-0351-15L</td>
<td>Preservation of Cultural Heritage:</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>U. Hassler</td>
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<td>Historicism in Zurich</td>
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<td>Historicism not only bequeathed prominent buildings and prevalent urban structures, but also turned Zurich into a major city. Through excursions to the historicist town, the seminar introduces the enormous range of historicism by reaching beyond the purely architectural style to technical and economical innovations.</td>
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<td>051-0367-15L</td>
<td>Seminar History of Urban Design: European Streets and Places - From the Urban Space to the Curbside</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>V. Magnago Lampugnani, H. Stühlinger, M. Tubbesing</td>
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<td>Within our series «Elements of the urban space» we will focus on the urban detail in the forthcoming semester. By looking at international case studies located amongst others in Zurich, Paris, Amsterdam, Berlin, London, and Milano we will approach this complex cultural phenomenon on the level of the metropolis, the neighborhood, the building and the urban detail.</td>
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<td>The aim of the seminar series is to provide a sound methodological approach in analyzing urban space on the scale of the metropolis, the neighborhood, the building and the urban detail. In the discourse of the seminar, we will gain fundamental criteria for the design of urban situations.</td>
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<td>Our students will be provided with the script in digital form.</td>
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<td>We will provide our students with a selection of literature and all necessary planning documents in digital form.</td>
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Data: 06.12.2018 13:04
Autumn Semester 2015
Page 83 of 1432
In this theory seminar we read and discuss a range of recent papers and book chapters which analyze these new phenomena of planetary urbanization. The number of students is limited to 60. After the introduction on 17/09 we will take two walks through Zurich on 24/09 and 01/10 between 14.45 and 16.00. Our joint presentations will take place on 15/10 and 26/11. Furthermore, we ask our students to participate in 4 short consultations on 08/10., 29/10., 05/11., 12/11., 19/11. or 14.01. (doodle). Apart from the city walks and the two mandatory presentation events, it is possible to attend a seminar taking place at the same time. To give time for the preparation of the final crits, there will be no consultations on 3/12, 10/12 and 17/12.

### 051-0783-15L
**The History of the gta - An Oral History Project**

**Abstract**
This seminar focuses on the interview, and more broadly oral history within art and architectural history. We will also interview the protagonists who shaped the history of the gta.

**Objective**
We will approach both the historical and theoretical dimensions of the interview as a research tool while also developing practical interview skills.

**Content**
This seminar focuses on the interview, and more broadly oral history within art and architectural history. In the class, we will read and discuss texts as well as prepare and conduct interviews with protagonists who shaped the formation and history of the Institute for the History and Theory of Architecture (gta) at ETH Zurich, founded in 1967. We will approach the interview both as a historical and theoretical subject while also developing practical interview skills. One short presentation in class as well as an interview are required.

**Lecture notes**
The seminar will span two semesters, fall 2015 and spring 2016.

**Prerequisites / notice**
Das Seminar is open for master students and doctoral students.

### Sociology / Economy

#### Number

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<th>Number</th>
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<td>851-0252-03L</td>
<td>Cognition in Architecture - Designing Orientation and Navigation for Building Users</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>V. Schinazi, B. Emo Nax, C. Hölscher</td>
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</table>

**Abstract**
How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.

**Objective**
Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition are introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they memorize the environment and how they find their way from A to B. Students will also learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking and behavior simulation for design. Students will reflect on the roles of designers and other stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture/planning, engineering, computer science and behavioral science as well as anybody interested in the relation between design and cognition.

**Architecture students can obtain course credit in “Vertiefungsfach” or “Wahlfach”**

#### 051-0165-15L
**Housing**

**Abstract**
Module 1: Suburban Housing
Module 2: Urban Housing

**Objective**
Students should be able to recognise and place in context the characteristic features of suburban and urban housing. They will get to know the architectural, socio-cultural aspects of suburban and urban housing.

**Content**
Housing considered in context: architectural, cultural, social, technical and economic conditions and processes influence housing and modes of habitation. To what extent have they changed in the last century? The construction and renovation of domestic space is a cultural process. What forces construct that space, and according to which criteria? What are the constructional and organizational solutions with which they confront the diversity and metamorphosis of contemporary modes of habitation? How can postulates concerning a sustainable development be implemented? Insights culled from housing research and practice, podium discussions with guests and current examples of innovative housing are included.

**Literature**
as grundlegende Einführung:
Dietmar Eberle u. Marie Glaser (Hrsg.): Wohnen im Wechselspiel zwischen privat und öffentlich, Niggli Verlag 2009

Leseliste: Obligatorische Literatur zum Thema ist unter www.wohnforum.arch.ethz.ch/abrubar

#### 051-0619-15L
**Urban Mutations on the Edge: Concrete, Part 1**

**Abstract**
The Urban Mutations on the Edge seminar is a series of public lectures by ETH faculty and invited guests addressing the dynamic global peripheries that we believe are most actively changing our conception of the city.

**Objective**
Participants should leave the course with an understanding of current urban research issues and an introduction to the political dimension of contemporary architectural production.

**Lecture notes**
Texts to accompany and provide context for each lecture are sent weekly by email.

#### 051-0813-15L
**Sociology: Planetary Urbanization - A Theory Workshop**

**Abstract**
In the last decades, urbanization has become a planetary phenomenon, leading to an intense debate about a new conceptualization of urbanization. This theory seminar aims at giving an introduction into the actual debate on planetary urbanization, into urban theory, theoretical thinking and the work with scientific texts.

**Objective**
This elective course highlights the sociological perspective on architectural practice and provides an introduction to sociological research. It focusses on two main procedures: on the one hand, a systematic reading and discussion of theoretical texts, and on the other, empirical case studies of social aspects of the production of the built environment. In this course, a wide set of qualitative research methods is used (including various forms of interview, participant observation, image and text analyses). This approach enables students to gain their own experience by dealing with the various participants and constellations in the social field of architecture and building construction, and to familiarize themselves with the approaches and perceptions of various different participants.

**Content**
In this theory seminar we read and discuss a range of recent papers and book chapters which analyze these new phenomena of planetary urbanization, such as the implosion and explosion of urban regions, the disintegration of contiguous “hinterlands”, the emergence of corridor urbanization, the large scale industrialization and urbanization of agricultural areas, the production of extended urban fabrics of islands, the creation and extension of operational landscapes, as well as processes that lead to the end of the “wilderness” and the urbanization of ocean space.

**Literature**
The relevant texts will be distributed in the seminar. A very good overview is provided in the following edited volume: Brenner, Neil (ed.): Implosions / Explosions: Towards a Study of Planetary Urbanization. Jovis, Berlin, 2014.

#### Thesis Electives

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<td><strong>Navigation for Building Users</strong></td>
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<td><strong>Particularly suitable for students of D-ARCH</strong></td>
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<tr>
<td>051-0165-15L</td>
<td>Urban Mutations on the Edge: Concrete, Part 1</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Angélil</td>
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</table>

**Abstract**
The Urban Mutations on the Edge seminar is a series of public lectures by ETH faculty and invited guests addressing the dynamic global peripheries that we believe are most actively changing our conception of the city.

**Objective**
Participants should leave the course with an understanding of current urban research issues and an introduction to the political dimension of contemporary architectural production.

**Lecture notes**
Texts to accompany and provide context for each lecture are sent weekly by email.

### Theory Electives

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</table>

**Abstract**
How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.

**Objective**
Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition are introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they memorize the environment and how they find their way from A to B. Students will also learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking and behavior simulation for design. Students will reflect on the roles of designers and other stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture/planning, engineering, computer science and behavioral science as well as anybody interested in the relation between design and cognition.

**Architecture students can obtain course credit in “Vertiefungsfach” or “Wahlfach”**

### Autumn Semester 2015
The seminar aims to analyse housing in context. Group discussions, working with literature and data material as well as the elective thesis focus on architectural, cultural, social and economic conditions and processes that influence housing and the modes of habitation.

The objectives are to understand the challenges that arise with these aspects of sustainability, to dimension the resulting technical systems and components, and to implement this in architecture.

Language: German or English

**6 credits**

063-0165-15L **Housing (Elective Thesis)**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>11A</th>
<th>G. Precht</th>
</tr>
</thead>
</table>

**Abstract**
The seminar aims to analyse housing in context. Group discussions, working with literature and data material as well as the elective thesis focus on architectural, cultural, social and economic conditions and processes that influence housing and the modes of habitation.

**Objective**
The students will provide a differentiated analysis on the subject housing within its social, cultural and economic context. By working scientifically on a individually chosen subject in their elective thesis, they reflect and analyse on the major problems and determine the players and practices, as well as they depict well structured outcomes.

**Content**
The seminar aims to analyse housing in context. Group discussions, working with literature and data material as well as the elective thesis focus on architectural, cultural, social and economic conditions and processes that influence housing and the modes of habitation.

**Literature**
Siehe LITERATURLISTE unter: http://www.wohnforum.arch.ethz.ch/lehre/wiss_wahlfach-wohnen.html

**Prerequisites / notice**
Zum methodischen Verfassen einer Wahlfacharbeit siehe das Merkblatt unter: http://www.wohnforum.arch.ethz.ch/lehre/wiss_wahlfach-wohnen.html

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**6 credits**

063-0169-15L **Seminar Architectural Criticism (Thesis Elective)**

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<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>11A</th>
<th>L. Stalder</th>
</tr>
</thead>
</table>

**Abstract**
In the framework of three elective courses, students need to prepare elective works (seminar works).

**Objective**
The aim of these papers is to foster an independent engagement with the subjects of the seminar. A scientific familiarization with the respective themes is required. The extent of such a paper ranges from 20 to 30 pages.

**Content**
The contents of these elective studies are expected to link to the subject matter of the course architectural criticism.

**Prerequisites / notice**
Interested students are kindly asked to contact us in order to discuss possible projects.

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**6 credits**

063-0171-15L **History, Criticism and Theory of Architecture (Thesis Elective)**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>11A</th>
<th>L. Stalder</th>
</tr>
</thead>
</table>

**Abstract**
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

**Objective**
The goal is to develop a framework of questions within the field of the history and theory of architecture as well as cultural history and to discuss it in a text that will form a scientific thesis. Personal viewpoints and arguments should be based on historical and theoretical sources and literature, and should be presented with reference to the source.

**Prerequisites / notice**
Application for the coursework with the lecuturer also via e-mail: San Keller <stefan.keller@arch.ethz.ch>

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**6 credits**

063-0173-15L **Spatial Concepts in Film and Architecture (Thesis Elective)**

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<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>11A</th>
<th>D. E. Agotai Schmid, M. Bächtiger Zwicky</th>
</tr>
</thead>
</table>

**Abstract**
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

**Objective**
The aim of these papers is to foster an independent engagement with the subjects of the seminar. A scientific familiarization with the respective themes is required. The extent of such a paper ranges from 20 to 30 pages.

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**6 credits**


<table>
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<th>W</th>
<th>6 credits</th>
<th>11A</th>
<th>M. Peter</th>
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</table>

**Abstract**
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

**Objective**
The aim of the Thesis Elective is an independent engagement with the subjects of the related Elective Course.

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**6 credits**

063-0193-15L **Performance and Intervention (Thesis Elective)**

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<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>11A</th>
<th>S. Keller Roca</th>
</tr>
</thead>
</table>

**Abstract**
Individual completion of an artistic project and public presentation (elective coursework).

**Objective**
Creative Experience: Definition of ones own interests and realization of an artistic project. Development of an advanced concept of performance and intervention.

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**6 credits**

063-0195-15L **Criticim and Theory (Thesis Elective)**

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<tr>
<th>W</th>
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<th>11A</th>
<th>K. Sander</th>
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</table>

**Abstract**
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

**Objective**
The aim of the Thesis Elective is an independent engagement with the subjects of the related Elective Course.

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**6 credits**

063-0197-15L **Photography (Thesis Elective)**

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<th>W</th>
<th>6 credits</th>
<th>11A</th>
<th>K. Sander</th>
</tr>
</thead>
</table>

**Abstract**
Individual completion of an artistic project with photography and public presentation (elective coursework).

**Objective**
Creative Experience: Definition of ones own interests and realization of an artistic project based on photography. Development of an advanced concept of photography.

**Prerequisites / notice**
Application for the coursework with the lecuturer also via e-mail: Katja Eydel / eydel@arch.ethz.ch

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**6 credits**

063-0201-15L **3D Scanning and Freeform Modeling (Thesis Elective)**

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<th>W</th>
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<th>K. Sander</th>
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</table>

**Abstract**
Individual completion of an artistic project with 3-d photography (scanning) and digital modeling (elective coursework).

**Objective**
Creative Experience: Definition of ones own interests and realization of an artistic project using 3d photography and digital modeling. Experimental research for expanded usage of this tools.

**Prerequisites / notice**
Participation at the elective course "3D Scanning and Freeform Modeling" Application for the coursework with the lecuturer also via e-mail: San Keller <stefan.keller@arch.ethz.ch>

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**6 credits**

063-0219-15L **Artistic and Conceptual Thinking and Working (Thesis Elective)**

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<thead>
<tr>
<th>W</th>
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<th>S. Keller Roca, N. Freiherr von Rosen</th>
</tr>
</thead>
</table>

**Abstract**
Creative Experience: Definition of ones own interests, development, and realization of an artistic project.

**Prerequisites**: "Artistic and Conceptual Thinking and Working". Issues and questions of the artistic project can be brought to the course.
The main aim of this seminar is learning the scientific handling of theoretical texts on the city. These texts range from pamphlets, to E. Perotti History of Urban Design (Thesis Elective) N. Zschocke Theory of Architecture (Thesis Elective) Essay on a Subject from the Field of Architectural History, N. K. Naehrig 11A The architectural drawing establishes itself from the very first sketch up to a representative image as an important "decision-maker" for the progress of the design project. The necessary intensity, technology and experimental keen, as also the search for new forms of representations should be sought. The visit of the elective is assumed. Project proposal please to: faeser@arch.ethz.ch

Objective Individual completion of an artistic project (elective coursework). The ideas, questions, and above all the actual (partial) results of the artistic project will be discussed collectively. Input sessions are organized according to individual requirement.

Prerequisites / notice Application for the coursework with the lecutor also via e-mail: San Keller <stefan.keller@arch.ethz.ch>

Prerequisites: "Artistic and Conceptual Thinking and Working"; Issues and questions of the artistic project can be brought to the course.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credit Hours</th>
<th>Hours</th>
<th>Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0223-15L</td>
<td>Free Drawing (Thesis Elective)</td>
<td>6</td>
<td>W</td>
<td>Z. Leutenegger Küng</td>
</tr>
<tr>
<td>063-0227-15L</td>
<td>Architectural Drawing (Thesis Elective)</td>
<td>6</td>
<td>W</td>
<td>R. Fässer</td>
</tr>
<tr>
<td>063-0235-15L</td>
<td>Theory of Architecture (Thesis Elective)</td>
<td>6</td>
<td>W</td>
<td>A. Moravanzyk</td>
</tr>
<tr>
<td>063-0317-15L</td>
<td>History of Art and Architecture (Thesis Elective)</td>
<td>6</td>
<td>W</td>
<td>N. Zachocke</td>
</tr>
<tr>
<td>063-0355-15L</td>
<td>Preservation of Cultural Heritage (Thesis Elective)</td>
<td>6</td>
<td>W</td>
<td>U. Hassler</td>
</tr>
<tr>
<td>063-0369-15L</td>
<td>Theory of Urban Design (Thesis Elective)</td>
<td>6</td>
<td>W</td>
<td>K. Frey, E. Perotti</td>
</tr>
<tr>
<td>063-0415-15L</td>
<td>Trial of Structural Forms: History of Structural Design (Elective Thesis)</td>
<td>6</td>
<td>W</td>
<td>J. Schwartz, M. Rinke</td>
</tr>
</tbody>
</table>

Objective

- An elective master thesis in architectural theory is a written student assignment of an architectural problem or question, which is to be elaborated into a scientific paper in consultation with the advisors of the chair. The examination of a specific problem asks for a conscious and critical reflection of interdisciplinary approaches and methods.
- Within the framework of an elective master thesis the student can enhance the acquired knowledge in architectural theory in written form. The master thesis serves the acquisition of scientific methods, the formation, development and verbalization of conclusions and the contextualization within a theoretical setting. In a broader sense it serves the training of verbal skills, the development of a critical verbal, cognitive and imaginary access to problems in the realm of architecture and its neighboring disciplines in the humanities.
- Consultation for the individual elective thesis will be available during semester as well as during the free period. The oral examination at the end of the semester break is based on the written thesis, handed in before the the examination (watch the deadline in summer/winter). Appointments for consultation with the junior faculty by arrangement.
- The objective is to write an independent thesis on a monographic or thematic topic within the scope of the history of art and architecture. The focus is to thus exemplify a comprehensive view of the approach and methods towards the modern history of art.
- The objective is to write an independent thesis on a monographic or thematic topic within the scope of the history of art and architecture.
- The purpose is to write a scholarly essay on a topic from the field of architectural history. The aim of the elective course paper is to discuss a topic freely selected from the field of architectural history, in agreement with the assistant lecturer(s). In addition to original ideas, positions taken in history of research on the subject should also be discussed. It is important to use the correct scholarly format and clear language. The paper should be approximately 40'000 characters in length and should also include as much pictorial material as needed.

Prerequisites / notice

- Independent and scientific thesis on a monographic or thematic topic within the scope of the history of art and architecture.
- The general aim of this intensification is teaching competency in analysis and interpretation in the following areas: knowledge of artifacts, dynamics of systems, historical contexts, history of knowledge and theory as well as an approach to scholarly work.
- Contents depend on the specific curriculum of each semester and will be determined in consultation with the faculty advisor. Independent study is possible, however, only after consultation.
- The objective of the elective subject is, in coordination with the advisors, to work autonomously on a subject from the history of architecture. Beside own ideas also positions of research should be considered; we set value on a correct scientific form as well as a clear language. The work should cover 36'000 signs as well as image material if needed. At the beginning and before delivery of the work an elaborate discussion will take place.
- The ideas, questions, and above all the actual (partial) results of the artistic project will be discussed collectively. Input sessions are organized according to individual requirement.
- The focus is to thus exemplify a comprehensive view of the approach and methods towards the modern history of art.
- The objective of the elective subject is, in coordination with the advisors, to work autonomously on a subject from the history of architecture. Beside own ideas also positions of research should be considered; we set value on a correct scientific form as well as a clear language. The work should cover 36'000 signs as well as image material if needed. At the beginning and before delivery of the work an elaborate discussion will take place.
- The visit of the elective is assumed.
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We use the term digital materiality to describe an emergent transformation in the expression of architecture. Materiality is increasingly being enriched with digital characteristics, which substantially affect architectures physis. Digital materiality evolves through the interplay of design data. The architect as author of these data takes a key role in this development. Materiality is increasing enriched with digital characteristics, which substantially affect architectures physis. Digital materiality evolves through the interplay between digital and material processes in design and construction. The synthesis of two seemingly distinct worlds—digital and the material—generates new, self-evident realities. Data and material, programming and construction are interwoven. This synthesis is enabled by the techniques of digital fabrication, which allows the architect to control the manufacturing process through design data. Material is thus enriched with information; material becomes informed. In the future, architects ideas will permeate the fabrication process in its entirety. This new situation transforms the possibilities and thus the professional scope of the architect. It's imperative that the topic of the work is discussed with and accepted by the chair in advance.

### Building Physics (Thesis Elective)

**Objective**

Getting to know important critical figures between architecture and engineering as well as their attitudes and concepts and the most distinguished buildings.

**Content**

Seminar to the studies and for discussion of important texts and buildings of the most famous construction engineers and architects by listening to reviews, presentations and models, input lectures and guest speeches, films and joint surveys.

**Abstract**

Within three elective courses, the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

**Objective**

The aim of the elective work is to gain comprehensive insight in specific issues related to urban physics and low-energy buildings. These issues may concern: wind & thermal comfort in the built environment, heat islands, cross-ventilation, driving rain, pollution dispersion, new technologies for low-energy buildings, design of building systems, optimal control.

**Prerequisites / notice**

It is imperative that the topic of the work is discussed with and accepted by the chair in advance.

**063-0515-15L**

**Prerequisites for Urban Physics:** successful termination of "Building Physics IV: Urban Physics".

For Building Physics in general: Knowledge in the relevant field.

**063-0619-15L**

**Urban Mutations on the Edge (Thesis Elective)**

**Objective**

Advance in technology revolutionizes design and fabrication processes within architecture. Digital fabrication allows immediate production from design data. The architect as author of these data takes a key role in this development.

**Abstract**

This Thesis Elective is an introduction to urban research, how to conduct it, and why it is a useful undertaking. The basis of the course is the Urban Mutations on the Edge lecture series. Additional seminar and individual meetings are held on select Thursdays throughout the semester.

**Objective**

The final product of the research is a publication-quality scientific article of approximately 2000 words that demonstrates a basic level of understanding and engagement within existing academic discourse. Work is typically conducted in teams of two.

**063-0621-15L**

**Architecture and Digital Fabrication (Thesis Elective)**

**Abstract**

Advance in technology revolutionizes design and fabrication processes within architecture. Digital fabrication allows immediate production from design data. The architect as author of these data takes a key role in this development. This course focuses on strategies for architectural production by means of algorithmic design tools and computer controlled fabrication methods.

**Objective**

The goal of the Wahlfacharbeit is the in-depth analysis of a topic in the field of digital design and fabrication. The students should develop a personal, algorithmic design system till fabrication. A theoretical placement of the work within the current research discourse is desirable.

**Content**

We use the term digital materiality to describe an emergent transformation in the expression of architecture. Materiality is increasingly being enriched with digital characteristics, which substantially affect architectures physis. Digital materiality evolves through the interplay between digital and material processes in design and construction. The synthesis of two seemingly distinct worlds—the digital and the material—generates new, self-evident realities. Data and material, programming and construction are interwoven. This synthesis is enabled by the techniques of digital fabrication, which allows the architect to control the manufacturing process through design data. Material is thus enriched with information; material becomes informed. In the future, architects ideas will permeate the fabrication process in its entirety. This new situation transforms the possibilities and thus the professional scope of the architect.

**Prerequisites / notice**

The elective thesis HS15 will be held as part of the current edition of the Swisspearl® Summerschool, 31.08. to 11.09.2015, thus on site, in the Eternit production facilities in Payerne! Everybody can participate in the Summerschool, enrolment details will be given within due time on the chair’s webpage.

**063-0625-15L**

**Serendipity (Thesis Elective)**

**Objective**

The thesis elective involves the creative refinement and testing of the theses on the perception of landscape developed during the semester in the elective course Serendipity.

**Abstract**

The thesis elective Serendipity offers students the opportunity to explore the possibilities of shaping perceptual qualities through the use of audiovisual tools.

**Content**

The subject of the elective thesis is tied to the correspondent elective subject.

**Prerequisites / notice**

Limited admission due to technical equipment.

**063-0627-15L**

**Topology (Thesis Elective)**

Self-depended thesis under the supervision of the tutor, alternately hold by the TheoryLab in the spring semester and the DesignLab in the autumn semester. It serves to continue the discussion with the themes of the elective course. The subject of the elective thesis is tied to the correspondent elective subject (precondition: enrolment to the course).

**Objective**

The elective gives students the opportunity to expand their knowledge in the area of landscape architecture. The subject of the elective thesis is tied to the correspondent elective subject. Is being offered in spring semester by the TheoryLab, in autumn semester by DesignLab.

Free thesis is only possible after consultation with the tutor and has to be well prepared by the student (statement, catalogue of questions).

**063-0629-15L**

**Pairi-Daeza: Threshold (Elective Thesis)**

The term "pairi-daeza", Persian for "a wall surrounding a garden", is the point of origin for an elective series addressing basic elements of landscape architecture. This semester, students will deal with the topic 'Threshold', developing a design for a metropolitan park in Lyon.

**Objective**

The term 'paradise' and its religious implications originate from 'pairi-daeza', Old Persian for 'a wall surrounding a garden'. Pairi-daeza is the title of an elective course series addressing basic elements of landscape architecture within the context of public space in European Metropolis, including the topics of border, threshold, water, vegetation, topography, choreography, and metaphor. The elective course serves as an introduction to landscape architectural design. Architecture students develop a project based on the perception of place, cognition of landscape-architectonic typologies, and conception of public space. They become familiar with model building as a design methodology as well as with representation in plan form. The design process is accompanied by workshops, lectures, excursions, critiques, and a workbook.

**Abstract**

The course is accompanied by a workbook with texts and background information.

**Prerequisites / notice**

For the elective Thesis it is a necessary condition to visit the elective course.
<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0667-15L</td>
<td>Case Studies in Urban Design (Thesis Elective)</td>
<td>6</td>
<td>Winter</td>
<td>K. Christiaanse</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>The aim of the elective works is to work independently in a scientific way on a problem in contemporary urban design.</td>
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<tr>
<td>063-0723-15L</td>
<td>Information Architecture (Thesis Elective)</td>
<td>6</td>
<td>Winter</td>
<td>G. Schmitt</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>The students can explore an ongoing subject from teaching or research of the chair “Information Architecture” in detail. In consultation with the chair individual topics are possible, too.</td>
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<tr>
<td>063-0731-15L</td>
<td>CAAD Practice (Thesis Elective)</td>
<td>6</td>
<td>Winter</td>
<td>L. Hovestadt</td>
</tr>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.</td>
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<tr>
<td>063-0733-15L</td>
<td>CAAD Theory (Thesis Elective)</td>
<td>6</td>
<td>Winter</td>
<td>L. Hovestadt</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td>063-0763-15L</td>
<td>New Focal Points of Construction (Thesis Elective)</td>
<td>6</td>
<td>Winter</td>
<td>D. Mettler, D. Studer</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Target of this self-dependent elective thesis is to rethink the constructive points base, wall, chamber, roof etc. on the basis of the newly acquired skills. A structurally engineered, well-founded hypothesis is formulated, thus serving as a initial position for the conception of future constructions.</td>
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<tr>
<td>063-0765-15L</td>
<td>Building Process: Economy (Thesis Elective)</td>
<td>6</td>
<td>Winter</td>
<td>H. Reichel</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Elective works serve the independent way of dealing with the contents of the according elective course.</td>
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<tr>
<td>063-0767-15L</td>
<td>Building Process: Thesis Elective</td>
<td>6</td>
<td>Winter</td>
<td>M. Eidenbenz</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td>063-0781-15L</td>
<td>Costruire correttamente/Constructing Correctly</td>
<td>6</td>
<td>Winter</td>
<td>G. Birindelli</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td>Writing a thesis elective will enable the student to carry out an architecturally and constructionally founded discussion of a topic (to be chosen by the student from the lecture material). The lessons learned and experience gained should stimulate the design work of the future architect.</td>
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</tbody>
</table>

Thesis Electives are reports oriented on the standards of social sciences. Students learn to write a scientific report which follows the state of the art in respect of content, methods, format, internal coherence and scientific validity.

**Objective**

The course will help frame an understanding of the forces shaping (in)formal urban forms and systems will characterise the research. Specific research goals tailored to individual interests will be discussed before proceeding.

**Literature**

The class material can be downloaded from the student-server. [http://u-ll.arch.ethz.ch](http://u-ll.arch.ethz.ch)

**Prerequisites / notice**

Maximum 30 students (working in groups of 3).

Please note the course starts at 14:45 pm.

---

**063-0819-15L**

**Planning Strategies for Complex Buildings - Example:**

**W** 6 credits 11A

**T. Guthknecht**

**Abstract**

Independently written scientific paper concerning a subject in the area of health facility planning and design with special focus upon the dynamic changes in health care services and the according planning and building reactions to them.

**Objective**

The objective is that the students engage in a debate of a differentiated functional planning as a basis for health care buildings which are to be successful medically, operationally and in design.

On the basis of a given scope of themes the students carry out research aiming for possible improvements in health facility planning. The scope of subjects is announced at the beginning of each semester.

**Content**

Health care buildings are subject to constant change. In a new hospital building 60% of the diagnostic and treatment areas are subject to building changes within the first 10 years of operation. Architecture has to develop concepts which accommodate this level of dynamics into the building structure in a better way.

In the coming years this need for adaptability is going to be challenges even further by the even more reducing health care resources. The paper should discuss in this context a specific question in detail by analysing problems and developing and discussing potential planning solutions.

---

**063-0823-15L**

**Material-Lab (Thesis Elective)**

W 6 credits 11A

**A. Spiro**

**Abstract**

The elective works serves an in depth case study through the construction of a 1:1 mock-up.

**Objective**

Content and output of the study to be agreed with the lecturer of the elective course.

---

**063-0855-15L**

**Master Class Construction (Thesis Elective)**

W 6 credits 11A

**C. Vogt**

**Abstract**

Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

**Objective**

The aim of the Thesis Elective is a independent engagement with the subjects of the related Elective Course.

---

**Seminar Weeks**

**Number**  **Title**  **Type**  **ECTS**  **Hours**  **Lecturers**

051-0911-15L  **Seminar Week Autumn Semester 2015**  W 2 credits 3A  Lecturers

**Abstract**

The seminar week is obligatory for students of all semesters. There are many and varied study contents.

**Objective**

The students will be enabled to discuss narrowly formulated factual questions in small groups and in direct contact with the professors.

---

**Compulsory Electives in Humanities, Social and Political Sciences**

- **Recommended GESS compulsory elective courses (Type B) for D-ARCH.**
- **see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability**
- **see GESS Compulsory Electives: Language Courses ETH/UZH**

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**Master Thesis**

**Number**  **Title**  **Type**  **ECTS**  **Hours**  **Lecturers**

051-0141-00L  **Master’s Thesis**  O 33 credits 40D  Professors

**Abstract**

Only students who fulfill the following criteria are allowed to begin with their master thesis:

- successful completion of the bachelor programme;
- fulfilling of any additional requirements necessary to gain admission to the master programme.

**Objective**

The Master-Thesis contains a written proposal due to a given master-programme within the work-field of an architect.

The Master-Thesis has to be an individual work by the students and be proof of the ability to independent design work.

---

**Course Units for Additional Admission Requirements**

**Number**  **Title**  **Type**  **ECTS**  **Hours**  **Lecturers**

051-1100-AAL  **Architectural Design V-IX**  E- 13 credits 16U  Lecturers

Enrolment only for MSc students who need this course as additional admission requirement.
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php)

Abstract
For Master students with additional obligations only! - Out of the offered courses "Architectural Design V-IX" the student is required to achieve 13 ECTS. There are 2 attempts only.

Objective
Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

<table>
<thead>
<tr>
<th>Architecture Master - Key for Type</th>
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<tbody>
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<td>W+</td>
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<td>W</td>
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<td>E-</td>
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<td>Z</td>
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<td>Dr</td>
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<th>Key for Hours</th>
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<tr>
<td>V</td>
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ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
Atmospheric and Climate Science Master

Modules

Weather Systems and Atmospheric Dynamics

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

Abstract: Dynamic, synoptic Meteorology

Objective: Understanding the dynamics of large-scale atmospheric flow

Content: Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic systems - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes: Dynamics of large-scale atmospheric flow

- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites: available (i.e. in English)

Climate Processes and Feedbacks

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<tr>
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<tbody>
<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>L. Johmann, B. Sierau</td>
</tr>
</tbody>
</table>

Abstract: Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth’s radiation balance. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes. In this course the sought-after topic of ice formation in clouds is studied from a theoretical and empirical perspective.

Objective: Students will gain an appreciation and understanding of the complex processes in clouds and the necessary physical phenomenon that are involved and need to be accounted for in order to study cloud and precipitation formation.

Content: - Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Lecture notes: available (i.e. in English)


Prerequisites: available (i.e. in English)


or


Climate and the Global Circulation of the Atmosphere

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-1250-00L</td>
<td>Land-Climate Interactions</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. I. Seneviratne, E. L. Davin</td>
</tr>
</tbody>
</table>

Abstract: The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

Objective: The students can understand the role of land processes and associated feedbacks for the climate system.

Lecture notes: Powerpoint slides will be made available

Prerequisites: Introductory lectures in atmospheric and climate science

Climate and the Global Circulation of the Atmosphere

<table>
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<tr>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4911-00L</td>
<td>Climate and the Global Circulation of the Atmosphere</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>T. Schneider</td>
</tr>
</tbody>
</table>

Abstract: Key features of the surface climate (e.g., the wind and temperature distribution) can be understood by considering how basic physical balances such as the angular momentum and energy balance constrain global atmospheric circulations. This course gives an overview of the physical balances involved and explores some of their implications for maintaining the surface climate.

Objective: Understanding the basic physical processes involved in maintaining the global circulation of the atmosphere and the surface climate (winds, temperature, precipitation, etc.). Ability to reason how climate may change on long timescales.

Content: Introduction to the physical balances and dynamical mechanisms governing global atmospheric circulations and the surface climate: angular momentum balance and its role in controlling winds; energy balance and its role in controlling temperatures; the hydrologic cycle and its role in controlling humidity and aridity; tracer transport and connections to the surface. The relative importance of mean circulations, transient eddies, and stationary eddies in these balances will be discussed, as will be the dynamics of their generation and maintenance. The course gives an overview of the dominant processes that govern the surface climate, with a focus on phenomena and order-of-magnitude physics that is applicable to climates generally, including those of Earth’s distant past and of other planets.
### Atmospheric Composition and Cycles

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<tbody>
<tr>
<td>402-0572-00L</td>
<td>Aerosols I: Physical and Chemical Principles</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>M. Gysel, U. Baltensperger, H. Burtscher</td>
</tr>
</tbody>
</table>

Abstract: Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.

Objective: Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields.

Content: Physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, absorption, extinction), aerosol production, physical and chemical characterization.

Lecture notes: Material is distributed during the lecture.

Literature:

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>102-0635-01L</td>
<td>Air Pollution Control</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>B. Buchmann, P. Hofer</td>
</tr>
</tbody>
</table>

Abstract: The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their impact on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society.

Objective: The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost.

Content: Part 1 Emission, Immission, Transmission:
- Fluxes of pollutants and their environmental impact
- Physical and chemical processes leading to emission of pollutants
- Mass and energy processes
- Emission measurement techniques and concepts
- Quantification of emissions from individual and aggregated sources
- Extent and development of the emissions (Switzerland and global)
- Propagation and transport of pollutants (transmission)
- Meteorological parameters influencing air pollution dispersion
- Deterministic and stochastic models, describing the air pollution dispersion
- Dispersion models (Gaussian model, box model, receptor model)
- Measurement concepts for ambient air (immission level)
- Extent and development of ambient air mixing ratios
- Goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies:
- The reduction of the formation of pollutants is done by modifying the processes (process-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration, electrostatic pre-cipitators, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms.
- Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
- Discussion of the technical possibilities to solve the actual air pollution problems.

Lecture notes: Brigitte Buchmann, Air pollution control, Part I
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises

Literature:
- Lecture slides and exercises
- Peter Hofer, Air pollution control, Part II

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<th>Number</th>
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<tr>
<td>701-1233-00L</td>
<td>Stratospheric Chemistry</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>T. Peter, A. Stenke</td>
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</table>


Objective: The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.

Content: Short presentation of thermodynamical and kinetic basics of chemical reactions; bi- and thermonolecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the oxygen species with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chlorine activation.

Lecture notes: Documents are provided in the contact hours.

Literature:

Prerequisites / notice: Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.

701-1233-00 V starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

### Climate History and Paleoclimatology

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The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced development of a basic knowledge and understanding of the main tools available for the quantitative analysis of geochemical data.

Climate History and Palaeoclimatology

Sedimentology II: Biological and Chemical Processes
-
- Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
- C-cycle, carbonates, Corg : CO2 sources and sink
- Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
- Marine sediments through geological time
- Carbonates and evaporites
- Lacustrine carbonates
- Economic aspects of limestone

We will discuss how these methods are applied in a range of Earth Science fields, from cosmochemistry, through mantle and crustal geochemistry, volcanology and igneous petrology, to chemical oceanography.

A special emphasis will be put on dealing with geochemical problems through modeling. Where relevant, software packages will be introduced and applied to real geochemical data.

The grading of students is based on in-class exercises and end-semester examination.
Analysis of Climate and Weather Data

The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

Objective
The students can understand the role of land processes and associated feedbacks for the climate system.

Lecture notes
Powerpoint slides will be made available

Prerequisites / notice
Prerequisites: Introductory lectures in atmospheric and climate science

Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in the Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

Abstract
Concepts for non-ideal boundary layer conditions
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Content
- Introduction
- Turbulence
- Statistical tratment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory

Lecture notes
available (i.e. in English)

Literature

Prerequisites / notice
Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahes Programmieren.

Hydrology II

The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective
Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modellisation with practical examples.

Content

Abstract
The course contains an extensive semester project.

Lecture notes
Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature
Additional literature is presented during the course.

Hydrology and Water Cycle

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<tbody>
<tr>
<td>701-1251-00L</td>
<td>Land-Climate Interactions</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. I. Seneviratne, E. L. Davin</td>
</tr>
<tr>
<td>701-1253-00L</td>
<td>Analysis of Climate and Weather Data</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Frei</td>
</tr>
<tr>
<td>651-4053-05L</td>
<td>Boundary Layer Meteorology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Rotach, P. Calanca</td>
</tr>
</tbody>
</table>


and/or


Prerequisites: Introductory lectures in atmospheric and climate science

ELECTIVES

The students are free to choose individually from the entire course offer of ETH Zürich and the universities of Zürich and Bern.

WEATHER SYSTEMS AND ATMOSPHERIC DYNAMICS

Courses are only offered in FS.
Two additional courses are offered in HS by University of Berne.

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<tbody>
<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Haug, A. Martinez-Garcia</td>
</tr>
</tbody>
</table>

**Abstract**
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimatic research.

**Objective**
The student will have an understanding of evolution of climate and its major forcing factors - orbital, atmosphere chemistry, tectonics - through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary palaeoclimatic archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

**Content**
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Geological time, stratigraphy, geological archives, climate archives, palaeoclimate proxies

Climate through geological time: "lessons from the past"

Cretaceous greenhouse climate

The Late Paleocene Thermal Maximum (PETM)

Cenozoic Cooling

Onset and Intensification of Southern Hemisphere Glaciation

Onset and Intensification of Northern Hemisphere Glaciation

Pliocene warmth

Glacial and Interglacials

Millennial-scale climate variability during glaciations

The last deglaciation(s)

The Younger Dryas

Holocene climate - climate and societies

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<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

**Abstract**
Dynamic, synoptic Meteorology

**Objective**
Understanding the dynamics of large-scale atmospheric flow

**Content**
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

**Lecture notes**
Dynamics of large-scale atmospheric flow

**Literature**
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

**Prerequisites / notice**
Physics I, II, Environmental Fluid Dynamics

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**Atmospheric Composition and Cycles**

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<tbody>
<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>U. Lohmann, B. Sierau</td>
</tr>
</tbody>
</table>

**Abstract**
Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth's radiation balance. Interactions between cloud particles can result in precipitation, glacioalvation or evaporation of the cloud depending on its microstructure and microphysical processes. In this course the sought-after topic of ice formation in clouds is studied from a theoretical and empirical perspective.

**Objective**
Students will gain an appreciation and understanding of the complex processes in clouds and the necessary physical phenomenon that are involved and need to be accounted for in order to study cloud and precipitation formation.

**Content**
Microstructure of clouds and precipitation, aerosol activation to form cloud droplets, ice crystal nucleation (homogeneous freezing of supercooled aerosol and heterogeneous freezing), precipitation formation

**Lecture notes**
Powerpoint slides will be made available

**Literature**

**Prerequisites / notice**
At least one introductory course in Atmospheric Science or Instructor's consent.

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<tr>
<th>Number</th>
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<tr>
<td>651-4053-05L</td>
<td>Boundary Layer Meteorology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Rotach, P. Calanca</td>
</tr>
</tbody>
</table>

**Abstract**
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

**Objective**
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts.

Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).
Content
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Lecture notes
available (i.e. in English)

Literature

Prerequisites /
notice
Umwelt-Fluidodynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

Climate History and Paleoclimatology
Two courses are offered in autumn semester at University of Berne. ETH courses are only offered in FS.

Hydrology and Water Cycle

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4023-00L</td>
<td>Groundwater</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. O. Saar, X.Z. Kong</td>
</tr>
</tbody>
</table>

Abstract
The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective
a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

Content
1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.
2. Flow equation. The generalized Darcy law.
3. The water balance equation.
5. Analytical solutions to flow problems I
6. Analytical solutions to flow problems II
7. Finite difference solution to flow problems.
12. Analytical solutions to transport problems I.
13. Analytical solutions to transport problems II

Lecture notes
Handouts of slides.

Literature
de Marsily G., Quantitative Hydrogeology, Academic Press, 1986

102-0287-00L | Fluvial Systems     | W    | 3    | 2G    | P. Molnar

Abstract
The course presents an integrated view of the river basin and fluvial system. The fluvial system is viewed in terms of the dynamics in the transfer of water and sediment, the resulting geomorphology of the river network and streams, and finally the basin and river management options for conservation and restoration.

Objective
The goal of the course is to develop process understanding of fluvial systems and to introduce the students to appropriate analysis tools. In the first section the estimation of basin sediment supply from upland sheet, rill and gully erosion, and basin sediment yield are discussed. The second section focuses on sediment transport in rivers in general, e.g. basic mechanics of sediment laden flows, bedforms, flow resistance, sediment type and load measurement and estimation, the morphology of rivers. It is illustrated how the river network can be analysed in terms of its connectivity and topological characteristics. Channel stability and channel erosion modelling are discussed. The third section looks at fluvial system management in terms of engineering and nonstructural sediment (e.g. upland and channel erosion protection) and water (e.g. the importance of the natural streamflow regime on riverine ecosystem integrity, river rehabilitation) resource management.

Content
There is no script.
The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils. Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes, Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

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

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

Literature:
Supplemental textbook (not mandatory) - Environmental Soil Physics, by D. Hillel

Prerequisites:
The definition of prerequisites is part of the admission procedure for the master studies. You are informed by the admission office as to what courses of the section «prerequisites» you have to catch up with. You are accredited for these courses in the electives block of the master studies.
Atmospheric Physics
This lecture imparts the mathematical basis necessary for the development and application of moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, clouds and precipitation

Abstract
This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.

Objective
The students are able to explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features to explain how mountains influence the atmospheric flow on different scales

Content
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situtations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Literature
Rogers and Yau, A Short Course in Cloud Physics, Pergamon Press, 1989; Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Elsevier, 2006

50% of the time we use the concept of "flipped classroom" (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning. We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is an additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

Numerical Methods in Environmental Sciences
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Abstract
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Objective
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Content
Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary; a Matlab introduction is given). Example programs and graphics tools are supplied.

Numerical Modelling in Fortran
This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

Abstract
FORTAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

Additional Electives ETH

Course Catalogue of ETH Zurich

Minor in Physical Glaciology
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<th>Number</th>
<th>Title</th>
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<tr>
<td>101-0289-00L</td>
<td>Applied Glaciology</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Funk, A. Bauder</td>
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</table>

**Abstract**

We shall explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

**Objective**

To understand the fundamental physical processes in glaciology.
To learn some basic numerical modelling techniques for glacier flow.
To identify glaciological hazards and to learn some assessment and mitigation possibilities.

**Content**

Basics in physical glaciology
- Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges
- Ice falls, ice avalanches
- Glacier floods
- Lake ice and bearing capacity

**Lecture notes**

Handouts are available

**Literature**

Relevante Literatur wird während der Vorlesung angegeben.

**Prerequisites / notice**

Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Voraussetzungen: Es werden Grundkenntnisse in Mechanik und Physik vorausgesetzt.

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<tr>
<td>651-4101-00L</td>
<td>Physics of Glaciers</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
<td>M. Lüthi, G. Jouvet, F. T. Walter</td>
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</table>

**Abstract**

Application of basic physical concepts to glaciers and ice caps. Understanding glaciers and ice sheets with simple physical concepts.
Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.

**Objective**

The course outlines the physical principles governing the gravity-driven motion of glacier ice. This is applied to understand the response of glaciers and ice sheets to changes in their environment. Polar ice caps, ice streams and mountain glaciers and their recent rapid changes are discussed.

**Content**

The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

**Lecture notes**

Good high school mathematics and physics knowledge required.

**Literature**

http://people.ee.ethz.ch/~luethim/teaching.html

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<tr>
<td>651-4077-00L</td>
<td>Quantification and Modeling of the Cryosphere: Dynamic Processes</td>
<td>W</td>
<td>3 credits</td>
<td>1V</td>
<td>University lecturers</td>
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</table>

**Abstract**

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO815

**Objective**

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Content**

Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

**Lecture notes**

Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.

**Prerequisites / notice**

Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes

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<tr>
<td>651-1581-00L</td>
<td>Seminar in Glaciology</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>A. Bauder</td>
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</table>

**Abstract**

Study aktueller und klassischer Arbeiten der glaziologischen Forschung

**Objective**

Vertiefte Kenntnisse in ausgewählten Bereichen der glaziologischen Forschung erarbeiten. Kennenlernen von Formen der interdisziplinären Zusammenhänge.

**Content**

Studium aktueller und klassischer Arbeiten der glaziologischen Forschung

**Lecture notes**

benötigte Unterlagen werden im Verlauf der Veranstaltung abgegeben

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### Minor in Biogeochemistry

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<tbody>
<tr>
<td>701-1313-00L</td>
<td>Isotopic and Organic Tracers in Biogeochemistry</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>R. Kipfer, C. Schubert</td>
</tr>
</tbody>
</table>

**Abstract**

The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course "Isotopic and Organic Tracers Laboratory".

**Objective**

The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications.

**Content**

- Geochemical analysis (source, decay chains);
- Stable isotopes in biogeochemistry (natural abundance, fractionation);
- Geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes.

**Lecture notes**

A list of relevant books and papers will be provided

**Prerequisites / notice**

Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent)

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<tbody>
<tr>
<td>701-1315-00L</td>
<td>Biogeochemistry of Trace Elements</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Voegelin, J. G. Wiederhold, L. Winkel</td>
</tr>
</tbody>
</table>

**Abstract**

The course addresses major biogeochemical processes that drive the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The course is structured as follows:

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>Literature</th>
<th>Content</th>
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<tbody>
<tr>
<td>None</td>
<td>Will be distributed</td>
<td>The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.</td>
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</table>

### 701-1341-00L Water Resources and Drinking Water

**Objective**
The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components will be discussed. Relevant methods/techniques to study these processes will be presented.

**Abstract**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

**Objective**
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

**Content**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

**Lecture notes**
Handouts will be distributed

**Literature**
Will be mentioned in handouts

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
</tbody>
</table>

### 701-1346-00L Carbon Mitigation

**Objective**
The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

**Abstract**
The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

**Content**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

**Lecture notes**
None

**Literature**
Will be identified based on the chosen topic.

**Prerequisites / notice**
Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

### 701-1551-00L Sustainability Assessment

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

**Abstract**
The course is seminar-like, interactive.

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

**Lecture notes**
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

**Literature**
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

**Prerequisites / notice**
Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

## Minor in Global Change and Sustainability

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<tr>
<th>Number</th>
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<tr>
<td>701-0015-00L</td>
<td>Seminar on Transdisciplinary Research for Sustainable Development</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. E. Pohl, M. Staffacher</td>
</tr>
</tbody>
</table>

**Abstract**
The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

**Objective**
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

**Content**
The seminar covers the following topics:
1. Theories and concepts of inter- and transdisciplinary research
2. The specific challenges of inter- and transdisciplinary research
3. Involving stakeholders
4. Collaborating disciplines
5. Exploration of tools and methods
6. Analysing participants' projects to improve inter- and transdisciplinary elements

**Literature**
Literature will be made available to the participants

**Prerequisites / notice**
The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

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<tr>
<td>701-1551-00L</td>
<td>Sustainability Assessment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Krüttli, C. E. Pohl</td>
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</table>

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

**Objective**
The course is seminar-like, interactive.

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

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

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

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<th>Number</th>
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<tbody>
<tr>
<td>051-0551-00L</td>
<td>Energy- and Climate Systems I</td>
<td>W</td>
<td>2</td>
<td>G</td>
<td>A. Schlüter</td>
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<tr>
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<td>Abstract</td>
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<td>components of building technologies for</td>
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<td>the efficient and sustainable energy</td>
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<td>their interaction with architecture and</td>
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<td>urban design. Using calculations, students</td>
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<td>assess the performance of solutions.</td>
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<td>of relevant systems for a efficient and</td>
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<td>sustainable climatisation and maintenance</td>
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<td>construction. By learning rough</td>
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<td>calculation methods, determination of</td>
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<td>relevant dimensions and identification of</td>
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<td>important parameters become possible.</td>
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<td>Hence, adequate approaches for the own</td>
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<td>design can be chosen, reviewed</td>
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<td>quantitatively and qualitatively and set</td>
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<td>in with a synergistic effect.</td>
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<td>Content</td>
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<td>1. Introduction</td>
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<td>2. Thermal systems</td>
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<td>3. Ventilation</td>
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<td>4. Daylight and artificial lighting</td>
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<td>EK I lectures focus on technical components</td>
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<td>in use as well as their rough calculation</td>
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<td>methods and their integration into design</td>
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<td>and construction.</td>
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<td>Based on EK I, the EK II lectures focus</td>
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<td>on all possible systems and concepts available to the architect for a sustainable design.</td>
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<td>Lecture notes</td>
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<td>The Slides from the lecture serve as lecture notes and are available as download.</td>
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<td>Literature</td>
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<td>A bibliography will be distributed at the beginning of the lecture.</td>
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<tr>
<td>227-0731-00L</td>
<td>Power Market I - Portfolio and Risk</td>
<td>W</td>
<td>6</td>
<td>G</td>
<td>D. Reichelt, G. A. Koeppel</td>
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<td></td>
<td>Management</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model, strategy development and positioning.</td>
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<td>Content</td>
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<td>1. Pan-European power market and trading</td>
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<td>1.1. Power trading</td>
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<td>1.2. Development of the European power markets</td>
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<td>1.3. Energy economics</td>
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<td>1.4. Spot and OTC trading</td>
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<td>1.5. European energy exchange EEX</td>
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<td>2. Market model</td>
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<td>2.1. Market place and organisation</td>
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<td>2.2. Balance groups / balancing energy</td>
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<td>2.3. Ancillary services</td>
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<td>2.4. Market for ancillary services</td>
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<td>2.5. Cross-border trading</td>
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<td>2.6. Capacity auctions</td>
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<td>3. Portfolio and Risk management</td>
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<td></td>
<td>3.1. Portfolio management 1 (introduction)</td>
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<td>3.2. Forward and futures contracts</td>
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<td>3.3. Risk management 1 (m2m, VaR, hpcf, volatility, cVaR)</td>
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<td>3.4. Risk management 2 (PaR)</td>
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<td>3.5. Contract valuation (HPFC)</td>
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<td>3.6. Portfolio management 2</td>
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<td>2.8. Risk Management 3 (enterprise wide)</td>
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<td>4. Energy &amp; Finance I</td>
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<td>4.1. Options 1 basics</td>
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<td>4.2. Options 2 hedging with options</td>
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<td>4.3. Introduction to derivatives (swaps, cap, floor, collar)</td>
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<td>4.4. Financial modelling of physical assets</td>
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<td>4.5. Trading and hydro power</td>
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<td>4.6. Incentive regulation</td>
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<td></td>
<td>5. Strategy</td>
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<td>5.1. Strategic Positioning</td>
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<td>5.2. Development of strategies and examples</td>
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<td>5.3. Cases for team work</td>
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<td>Lecture notes</td>
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<td>Handouts of the lecture</td>
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<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>1 excursion per semester, 2 case studies, guest speakers for specific topics</td>
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<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>W</td>
<td>4</td>
<td>G</td>
<td>A. Wokaun, A. Steinfeld</td>
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<tr>
<td></td>
<td>The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry), Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.</td>
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<td>Objective</td>
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<td></td>
<td>Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.</td>
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</table>
Apply scientific project management techniques to your master project. The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

M. A. Wüest, H. Wernli, M. Wild, C. Schär, S. I. Seneviratne, N. Gruber, R. Knutti, T. Peter,

Fundamentals of chemistry and physics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

<table>
<thead>
<tr>
<th>Seminars and Colloquia</th>
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<tbody>
<tr>
<td><strong>Number</strong></td>
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<tr>
<td>651-4095-01L</td>
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<td>651-4095-03L</td>
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<tr>
<th>Laboratory and Field Courses</th>
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</table>

The course in the category «lab and field work» are only offered in spring semester.

<table>
<thead>
<tr>
<th>Master Thesis</th>
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<tbody>
<tr>
<td><strong>Number</strong></td>
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<tr>
<td>651-4275-00L</td>
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</table>
Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

The master thesis is under the supervision of a professor teaching in the module courses of the master programme. Please refer to the web page linked here for instructions and guidelines how to register for the master thesis (http://www.iac.ethz.ch/education/master/curriculum/master_thesis)

Abstract

Objective
Students are to prove their skills in working autonomously on a scientific project. They document their work in a scientific report.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0412-AAL</td>
<td>Climate Systems Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>R. Knutti</td>
</tr>
<tr>
<td>701-0471-AAL</td>
<td>Atmospheric Chemistry Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>D. W. Brunner, M. Ammann</td>
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<tr>
<td>701-0475-AAL</td>
<td>Atmospheric Physics Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>U. Lohmann</td>
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<tr>
<td>701-0473-AAL</td>
<td>Weather Systems Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>M. A. Sprenger, C. Grams</td>
</tr>
<tr>
<td>701-0461-AAL</td>
<td>Numerical Methods in Environmental Sciences</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>C. Schär, O. Fuhrer</td>
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</tbody>
</table>

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction of the most important components of the climate systems and their interactions.

Objective
Students have a basic understanding of the global energy balance, radiation budget, boundary, layer, atmosphere, ocean, biosphere, land-surface coupling, cryosphere, carbon cycle, climate variability, climate of the past and anthropogenic climate change, and they are able to apply this to solve simple quantitative problems and answer qualitative questions.

Lecture notes
Copies of the slides are provided in electronic form.

Literature
A comprehensive list of references is provided in the class. Two books are particularly recommended:

Prerequisites / notice
Teaching: Reto Knutti, several keynotes to special topics by other professors
Course taught in german, slides in english

Abstract
This is a self-study course targeted at Master students who did not follow the bachelor course "atmospheric chemistry" or similar. The course provides a general introduction into atmospheric chemistry.

Objective
The learning target of this lecture is a general overview on the most important processes of atmospheric chemistry and the various problems of the anthropogenic change in the structure of Earth's atmosphere.

Content
- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical Q3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: chemical properties, primary and secondary aerosol sources
- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols
- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

Prerequisites / notice
Basic courses in chemistry and physics are expected

Abstract
The fundamental background of cloud and precipitation formation (including thermodynamics and aerosol physics) and their relevance for climate are discussed.

Objective
The students can appreciate the processes leading to cloud and precipitation formation and their importance for climate. This lecture is the prerequisite for the MSc lectures cloud microphysics and cloud dynamics.

Content
- Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate; measurements of clouds (radar and satellites)

Lecture notes
Powerpoint slides and script will be made available

Literature
Rogers and Yau, A Short Course in Cloud Physics, Pergamon Press, 1989;
Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Elsevier, 2006

Abstract
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Objective
Introduction to basic aspects of atmospheric dynamics. Focus is given to the global-scale atmospheric circulation, synoptic-scale processes (in particular low-pressure systems), and the influence of mountains on the atmospheric flow.

Content
- Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes
Lecture notes and slides

Literature
Atmospheric Science, An Introductory Survey
John M. Wallace and Peter V. Hobbs, Academic Press

Abstract
Students are to prove their skills in working autonomously on a scientific project. They document their work in a scientific report.

Objective
Students are to prove their skills in working autonomously on a scientific project. They document their work in a scientific report.
Abstract
This lecture treats the mathematical and computational basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Objective
This lecture treats the mathematical and computational basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Content
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three tutorials, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary, a Matlab introduction is provided). Example programs and graphics tools are supplied.

Lecture notes
Provided on the webpage of the course: Lecture notes in German, tutorials in English.

Literature
List of literature is provided.

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### 701-1901-AAL Systems Analysis

<table>
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<tr>
<th>Enrolment only for MSc students who need this course as additional admission requirement.</th>
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<tr>
<td>E- 3 credits 6R  N. Gruber</td>
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Abstract
Self study course in Systems Analysis to fulfill requirements for enrollment into the master program. Topics covered include linear box models with one and several variables; non-linear box models with one or several variables; discrete-time models; and continuous models in space and time.

Objective
The aim of this course is to develop an understanding of the dynamical behavior of environmental systems and how this behavior can be captured and understood using mathematical concepts.

Lecture notes
For English Speaking students:
Chapters 12.3, 12.4, 18.2, 21, 22.1 and 22.2


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### 701-0106-AAL Mathematics V: Applied Deepening of Mathematics I - III

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<tr>
<th>Enrolment only for MSc students who need this course as additional requirement.</th>
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<td>E- 3 credits 6R  M. A. Sprenger</td>
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Abstract
Selected mathematical topics are presented for later use in more specialised lectures. Part of the topics were already discussed in the lectures Mathematics I-III. Here, they should be shortly recapitulated and most importantly applied to practical problems. If necessary, new mathematical concepts and methods will be introduced in order to solve challenging and inspiring problems from practice.

Objective
The aim of this lecture is to prepare the students for the more specialised lectures. They should become more familiar with the mathematical background, the mathematical concepts and most of all with their application and interpretation.

Content
Practical examples from the following areas will be discussed: ordinary differential equations; eigenvalue problems from linear algebra; systems of linear and nonlinear differential equations; partial differential equations (diffusion, transport, waves).

---

### Atmospheric and Climate Science Master - Key for Type

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

### Key for Hours

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

### ECTS
European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
Educational Science for Teaching Diploma and TC

These are the general course offerings of the programmes Teaching Diploma (TD) - categories Educational Science and Compulsory Elective Courses - and Teaching Certificate (TC) - category Educational Science.

▶ Educational Science Teaching Certificate

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<th>Number</th>
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<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. Stern</td>
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</table>

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

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

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

Lernformen:

**Lecture notes**
Folien werden zur Verfügung gestellt.

**Literature**

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

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W D2)</td>
<td>W</td>
<td>2 credits</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
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</tbody>
</table>

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

**Objective**
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

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</thead>
<tbody>
<tr>
<td>851-0240-16L</td>
<td>Current Research on MINT Learning</td>
<td>W</td>
<td>1 credit</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, E. Hafen, J. Hromkovic, N. Hungerbühler, A. Togni, A. Vaterlaus</td>
</tr>
</tbody>
</table>

**Abstract**
This colloquium focuses on the presentation of research projects conducted by the professorships participating in the competence center EducETH which concern learning in the STEM subjects. STEM stands for science, technology, engineering, and mathematics. Doctoral students and postdoctoral researchers will present their current projects and theoretical and methodological aspects will be discussed.

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

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
</tbody>
</table>

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

**Objective**
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

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

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
</tbody>
</table>

**Abstract**
This course can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW1)".
Abstract
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

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

851-0242-08L Research Methods in Educational Science
Number of participants limited to 30.

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

851-0240-03L Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)

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

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

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

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

Prerequisites / notice
Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:
- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
- Referat (RE)
- Schreiben einer schriftlichen Arbeit

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

Educational Science Teaching Diploma

<table>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
</tbody>
</table>

This course is only apt for students who intend to enrol in the programs "Teaching Diploma" or "Teaching Certificate". It is about learning in childhood and adolescence.

Objective
Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.
**Coping with Psychosocial Demands of Teaching (EW4)**

Enrolment possible with Teaching Diploma matriculation, except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW4.

**Support and Diagnosis of Knowledge Acquisition Processes (EW3)**

Enrolment only possible with matriculation in Teaching Diploma, except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW3.

**Designing Educational Environments in Physical Education (EW2 Sport)**

Compulsory course requirements for EW2 Sport: This course is required to be taken prior to EW4 Sport.

"Outdoor Education: Concepts and Practice" (851-0242-02L)

**Effective Learning Environments (EW 5)**

This is a mandatory course for students of the teacher's diploma for secondary schools, who have not completed
the course 851-0238-01L "Unterstützung und Diagnose von Wissenswerbprozessen" (EW 3) until the end of spring semester 2014 (except for students of Sport Teaching Diploma, who have completed the sport-specific course units EW2-4).

The successful completion of ALL modules relevant for the teacher's diploma is required for participation in this course.

Abstract

The students have to read the book "Lernwirksam unterrichten" from Felten/Stern and they have to answer the questions addressed on http://www.ifvll.ethz.ch/education/ew5. In individual or small-group sessions, Elsbeth Stern and the students will discuss how insights from learning research can inform classroom practice.

Objective

The focus of all classes on educational psychology is on scientific insights which help to reflect on instructional learning. In order to become professionals, teachers have to better understand students' behavior and achievement and thereby become aware of their scope of classroom practice. Students get a final opportunity to ask questions about psychological learning research.

Literature

Buch "Lernwirksam unterrichten" (Felten/Stern)

Prerequisites / notice

Detailed information: http://www.ifvll.ethz.ch/education/ew5

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>1</td>
<td>W</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>2</td>
<td>W</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>1</td>
<td>W</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>
This seminar will begin with a review of the literature on the teaching and learning of nature of science and scientific inquiry. It focuses on the development of adequate and functional understandings of nature of science and scientific inquiry.

Objective
Student teachers will develop an understanding of the concepts of nature of science and scientific inquiry. They will design a variety of instructional materials for teaching students about these concepts.

**Compulsory Elective Courses Teaching Diploma**

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>851-0240-16L</td>
<td>Current Research on MINT Learning</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, E. Hafen, J. Hromkovic, N. Hungerbühler, A. Togni, A. Vaterlaus</td>
</tr>
<tr>
<td>851-0250-05L</td>
<td>Introduction to &quot;Nature of Science&quot; and &quot;Scientific Inquiry&quot;</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>J. Egli</td>
</tr>
<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>T. Bernauer</td>
</tr>
</tbody>
</table>

**International Environmental Politics**
Particularly suitable for students of D-ITET, D-USYS

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

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

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

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

Lecture notes
Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your Nethz username and password to access the material.

Literature
See www.ib.ethz.ch (teaching, materials)

Prerequisites / notice
Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The workload for this course is approx. 120 hours (all inclusive).
Simultaneous enrolment in course "Lehr- und Lernort Berufsfachschule II: Förderung und Unterstützung von Berufslernenden" (UZH Module Code: 098GyZ03) is compulsory.

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
"The Vocational Schools as Sites of Teaching and Learning - Teaching Structure" sets out and discusses how to implement the specifications in the framework curriculum. This module is aimed at teachers in high schools awarding vocational school-leaving certificates (Berufsmatura) and all types of vocational schools. It also covers the link established with the company as a learning location.

Objective
- Formulating learning objectives at different levels, and implementing and monitoring these.
- Steering tuition in terms of content and method to fit in with the objectives.
- Formulating examination questions and assignments on the basis of the learning objectives set out in the curriculum and the teaching given.
- Selectively deploying different examination types and procedures/structuring selected learning contents logically in terms of the subject matter and learning process (from the concrete to the abstract, from the simple to the complex) and implementing these with different didactic visual aids.

Content
In the presentation, the framework and school curricula for the maturity level (all directions) are analysed and the subject matter is positioned in the context of the dual/trial system.

Lecture notes
- Handouts from the Dozenten and collection of working materials on the BSCW server.

Literature
- G. Steiner (2007): Der Kick zum effizienten Lernen. hep Verlag

Prerequisites / notice
Die Lehrveranstaltung ist seit September 2008 vom Bundesamt für Berufsbildung und Technologie akkreditiert.

851-0237-02L Vocational Schools as Sites of Teaching and Learning W II: Providing Encouragement & Support (UZH) 3 credits 2S University lecturers

No enrolment to this course at ETH Zürich. Book the corresponding module directly at UZH. UZH Module Code: 098GyZ03

Enrolment only possible with Teaching Diploma matriculation.
Simultaneous enrolment in course "Lehr- und Lernort Berufsfachschule I: Unterrichtsgestaltung" (UZH Module Code: 098GyZ01) is compulsory.

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
The module "vocational schools as sites of teaching and learning: providing encouragement and support for apprentices" aims to provide teachers at VET and professional baccalaureate institutions with ways of dealing with learners problems, particularly in connection with their being fed up with school, with job-seeking, school-to-work transition, or continuing education.

Objective
- The special situation of the learners in their double burden of work and school and pedagogically relevant can be.
- The overall thematic focus on the learners with problems, particularly in connection with their being fed up with school, with job-seeking, school-to-work transition, or continuing education.
- The learners as well as the learners with problems, particularly in connection with their being fed up with school, with job-seeking, school-to-work transition, or continuing education.
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Content
In the presentation, the learners in the dual/trial system are analysed and the learners' situation in terms of their double burden of work and school is discussed.

Lecture notes
- Handouts from the Dozenten and collection of working materials on the BSCW server.

Literature

Prerequisites / notice
Die Lehrveranstaltung ist seit September 2008 vom Bundesamt für Berufsbildung und Technologie akkreditiert.
851-0240-03L Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: 200u809x

Enrolment only possible with Teaching Diploma or DC matriculation.

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

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

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

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

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

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

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

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

Social Psychology

W 2 credits 2G H.D. Daniel, R. Mutz

Abstract
The lecture covers the following main topics: Social perception and interpersonal judgement; attitudes; group dynamics and group performance; leadership behavior and leadership styles.

Objective
The aim of the lecture is to impart a well-founded scientific understanding of social influence processes in individuals, groups, organizations, and social settings.

Content
Im Einzelnen sollen die Teilnehmerinnen und Teilnehmer lernen:
- an den Beispielen von Kaufverhalten oder ökologischem Verhalten zu beschreiben, wie Normen und Einstellungen Einfluss auf das Verhalten nehmen,
- die Subjektivität und die Fehlerquellen sozialer Wahrnehmung verstehen,
- Prinzipien der Psychologie der Kommunikation zu nutzen für eine Verbesserung der Kommunikation in Studium und Beruf,
- Merkmale und Strukturen von Gruppen zu identifizieren und mit geeigneten Methoden zu analysieren,
- Die Grundlagen von Konformität und Gehorsam gegenüber Autoritäten zu erkennen,
- Gruppenphänomene wie soziales Faulenzein, Risiko- und Konservativismus-Schub und Gruppendifferenzen entgegenzuwirken,
- Gruppenleistungen und -entscheidungen zu optimieren,
- Führungskünstlerleitungen entsprechend der Angaben in der Lehrveranstaltung
- Techniken zur Moderation von interagierenden Gruppen kennen zu lernen.

Literature

Philosophy of Science

W 3 credits 2V G. Hirsch Hadorn, C. J. Baumberger

Abstract
The lecture explores various strands in philosophy of science in a critical way, focusing on the notion of rationality in science, especially with regards to environmental research. It addresses the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

Objective
Students learn to engage with problems in the philosophy of science and to relate them to natural and environmental sciences, thus developing their skills in critical thinking about science and its use. They know the most important positions in philosophy of science and the objections they face. They can identify, structure and discuss issues raised by the use of science in society.

Content
1. Core differences between classical Greek and modern conceptions of science.
2. Classic positions in the philosophy of science in the 20th century: logical empiricism and critical rationalism (Popper); the analysis of scientific concepts and explanations.
3. Objections to logical empiricism and critical rationalism, and further developments: What is the difference between the natural sciences, the social sciences and the arts and humanities? What is progress in science (Kuhn, Fleck, Feyerabend)? Is scientific knowledge relativistic? What is the role of experiments and computer simulations?
4. Issues raised by the use of science in society: The relation between basic and applied research; inter- and transdisciplinarity; ethics and accountability of science.

Lecture notes
A reader will be available for students.
Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

Improved ability to assess current problems from a historical perspective and to critically interrogate one's own standpoint.

### Literature


Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.

### Prerequisites / notice

Students are asked to write an exam during the second last session (11.12.2015).

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### 701-0791-00L Environmental History - Introduction and Overview

**W 2 credits 2V D. Speich Chassé**

**Number of participants limited to 100.**

**Abstract**

Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

**Objective**

Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems.

**Lecture notes**

Course material is provided on OLAT.

**Literature**


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### 701-0701-01L Philosophy of Science: Exercises

**W 1 credit 1U G. Hirsch Hadorn, C. J. Baumberger**

**Abstract**

The exercises in philosophy of science serve to develop skills in critical thinking by discussing seminal texts about the rationality of science. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

**Objective**

Students can engage with problems in the philosophy of science and relate them to natural and environmental sciences. They learn to analyze and summarize philosophical texts. In this way, they develop their skills in critical thinking with a focus on the rationality of science.

**Content**

The optional exercises accompany the lecture and serve to develop skills in critical thinking with a focus on the rationality of science, based on discussing seminal texts. The texts cover important positions in the philosophy of science and their critics. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

---

### 401-9951-58L Didactics of Mathematics at the College Level I (University of Zurich)

**W 3 credits 2S R. Schelldorfer**

**Abstract**

Students are familiarised with the subjects taught at high-school level I (the first three years of the full-length high school or the first year of the reduced-length high school). The central contents of geometry, arithmetic and algebra, and also written mathematical problems are explained.

**Objective**

In the teaching given at high-school level I (the first three years of the full-length high school or the first year of the reduced-length high school), central concepts and approaches adopted in mathematics are introduced and observed in greater depth. These include variables, function, proof. This calls for a careful didactic analysis on the part of the teacher, requiring them to study and reflect on the prerequisites for the skills and the requirements in terms of mathematics and cognitive psychology.

**Content**

- Arithmetik und Algebra: Zahlbereiche, Form und Inhalt in der Algebra
- Geometrie: Konstruieren-Berechnen-Beweisen, dynamische Geometrie (Geogebra).
- Sachrechnen: Funktionsbegriff, mathematische Modellierung.
- Aktuelle mathematikdidaktische Aspekte wie Lernprozesse, Grundvorstellungen, Kompetenzen, offene Aufgaben.

---

### Educational Science for Teaching Diploma and TC - Key for Type

**Key for Hours**

- **V** lecture
- **G** lecture with exercise
- **U** exercise
- **S** seminar
- **K** colloquium

- **E-** Recommended, not eligible for credits
- **Z** Courses outside the curriculum
- **Dr** Suitable for doctorate

- **P** practical/laboratory course
- **A** independent project
- **D** diploma thesis
- **R** revision course / private study

**European Credit Transfer and Accumulation System**

- **ECTS** Special students and auditors need special permission from the lecturers.

---

**Transnational Mobility**

- [http://www.uzh.ch/studies/application/mobilitaet_en.html](http://www.uzh.ch/studies/application/mobilitaet_en.html)

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**Data: 06.12.2018 13:04**

**Autumn Semester 2015**

**Page 112 of 1432**
## Civil Engineering (General Courses)

### Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-1187-00L</td>
<td>Colloquium in Structural Engineering</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>B. Stojadinovic, E. Chatzi, M. Fontana, A. Frangi, W. Kaufmann, B. Sudret, T. Vogel</td>
</tr>
</tbody>
</table>

### Abstract
Professors from national and international universities, technical experts from the industry as well as research associates of the institute of structural engineering (IBK) are invited to present recent research results and specific projects from the practice. This colloquium is addressed to members of universities, practicing engineers and interested persons in general.

### Objective
Learn about recent research results in structural engineering.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-1387-00L</td>
<td>Colloquia in Geotechnics</td>
<td>E-</td>
<td>0 credits</td>
<td>A. Puzrin, G. Anagnostou, S. M. Springman</td>
</tr>
</tbody>
</table>

### Abstract
The Institute for Geotechnical Engineering invites distinguished speakers from research and practice, nationally and internationally. The colloquia are directed towards staff and students from Universities as well as engineers and scientists working in industry. Details can be obtained from www.igt.ethz.ch by following Events & Public Events. Some colloquia are available via webcast.

### Objective
Learn about recent research results in geotechnics.

### Civil Engineering (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Key Type</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

<table>
<thead>
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<th>Key</th>
<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

### ECTS

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>401-0241-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7 credits</td>
<td>5V+2U</td>
<td>M. Akveld</td>
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<td></td>
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<tr>
<td></td>
<td>Mathematical tools for the engineer</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Mathematics as a tool to solve engineering problems.</td>
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<tr>
<td></td>
<td>Basic mathematical knowledge for engineers.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Complex numbers</td>
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<td></td>
<td>Calculus for functions of one variable with applications.</td>
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<td>Simple Mathematical models in engineering.</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>In place of the German course 851-0703-03L Introduction to Law for Civil Engineering students can take the French course 851-0709-00L Droit civil.</td>
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<tr>
<td>401-0141-00L</td>
<td>Linear Algebra and Numerical Analysis</td>
<td>O</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>P. Grohs</td>
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<td></td>
<td>Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.</td>
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<td>Objective</td>
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<td></td>
<td>To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB.</td>
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<td>Content</td>
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<td></td>
<td>1. Linear systems of equations</td>
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<td>2. Vector and matrix calculus</td>
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<td>3. Subspaces and bases</td>
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<td>4. The Euclidean space Rn</td>
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<td>5. Numerical linear algebra with MATLAB</td>
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<td>6. Linear mappings (optional)</td>
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<td>7. Diagonalization (eigenproblems)</td>
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<tr>
<td></td>
<td>K. Nipp, D. Stoffer, Lineare Algebra, VdF Hochschulverlag ETH</td>
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<tr>
<td>252-0845-00L</td>
<td>Computer Science I</td>
<td>O</td>
<td>5 credits</td>
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<td>Abstract</td>
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<tr>
<td></td>
<td>The course covers the basic concepts of computer programming.</td>
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<td>Objective</td>
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<td></td>
<td>Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.</td>
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<td>Content</td>
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<tr>
<td>151-0501-00L</td>
<td>Kinematics and Statics</td>
<td>O</td>
<td>5 credits</td>
<td>3V+2U</td>
<td>E. Mazza</td>
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<tr>
<td></td>
<td>Master students in Human Movement Sciences and Sport</td>
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<td></td>
<td>MSc must enroll in &quot;Kinematics and Statics&quot; and &quot;Mechanics of Materials&quot; as a yearly course.</td>
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<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Statics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power</td>
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<td></td>
<td>Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction</td>
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<td>Objective</td>
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<td></td>
<td>The understanding of the fundamentals of statics for engineers and their application in simple settings.</td>
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<td>Content</td>
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<tr>
<td></td>
<td>Grundlagen: Lage eines materiellen Punktes; Geschwindigkeit; Kinematik, starrer Körper, Translation, Rotation, Kreiselung, ebene Bewegung; Kräfte, Reaktionsprinzip, innere und äussere Kräfte, verteilte Flächen- und Raumkräfte; Leistung</td>
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<td>Statik: Äquivalenz und Reduktion von Kräftegruppen; Ruhe und Gleichgewicht, Hauptsatz der Statik; Lagerbiegungen und Lagerkräfte, Lager bei Balkenträgern und Wellen, Vorgehen zur Ermittlung der Lagerkräfte; Paralleläre Kräfte und Schwerpunkt; Statik der Systeme, Behandlung mit Hauptsatz, mit Prinzip der virtuellen Leistungen, statisch unbestimmte Systeme; Statisch bestimmte Fachwerke, ideale Fachwerke, Pendelstützen, Knotengleichgewicht, räumliche Fachwerke; Reibung, Haftreibung, Gleitreibung, Gelenk und Lagerreibung, Rollreibung; Seilstatik; Beanspruchung in Stabträgern, Querkraft, Normalkraft, Biege- und Torsionsmoment</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>Übungsbücher</td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>Written session examination in &quot;Kinematics and Statics&quot; and &quot;Mechanics of Materials&quot; for D-MAVT Students, Students in Human Movement Sciences and Sport and all other Students, who take &quot;Kinematics and Statics&quot; and &quot;Mechanics of Materials&quot;:</td>
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<td>Part 1: 20 minutes: Neither notes nor calculators allowed right afterwards:</td>
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</tbody>
</table>
Abstract
This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.

Objective
This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.

Content

Lecture notes
Übungen zum Gesteinsbestimmen und Lesen von geologischen, tektonischen und geotechnischen Karten, einfache Konstruktionen.

Literature
Press, F.; Siever, R.: Allgemeine Geologie, Spektrum Akademischer Verlag, Heidelberg

851-0703-00L Introduction to Law for Civil Engineering W 2 credits
Only for Civil Engineering BSc, Geomatic Engineering and Planning BSc, Environmental Engineering BSc and Spatial Development and Infrastructure Systems MSc

Abstract
Students who have attended or will attend the lecture "Introduction to Law for Architecture" (851-0703-01L) cannot register for this course unit.

Objective
Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

Content

1. Public Law
Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

2. Private Law

Lecture notes
There will be ‘Lecture Notes’ (in German) for this course, starting in Fall 2015

Literature
Further information is available at http://www.hertig.ethz.ch/courses.htm

851-0709-00L Introduction to Civil Law W 2 credits

Abstract
The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.

Objective

Content
Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

Literature
Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des librairies.

Prerequisites / notice
Sont indispensables:
- le Code civil et le Code des obligations;
- Sont conseillées:
  - Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
  - Boillod, J.-P.: Manuel de droit, éd Statkine, Genève

Remarques
- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

Optional Colloquia

See the detailed schedule for the optional colloquia.

Compulsory Courses 3. Semester

Examination Block 1

See the detailed schedule for the examination block 1.

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 115 of 1432
Examination Block 2

In place of the German course 851-0703-01 Grundzüge des Rechts für Bauwissenschaften students can take the French course 851-0709-00 Droit civil.
The course explores the fundamental principles of Geomechanics and Geotechnical Engineering, with the following objectives:

- Introduction, statically determinate beams and frames
- Statics, flexure and axial force, shear, torsion
- Deflections, work equation
- Statically indeterminate systems

Note: The theoretical basic knowledge and detailing of plate girders, trusses and composite beams and columns is covered in the course.

Literature


Bachelor Studies (Programme Regulations 2010)

Compulsory Courses 5. Semester

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0505-00L</td>
<td>Mechanics III for Civil Engineers</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>to be announced</td>
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</tbody>
</table>

Objective
2. Linear oscillations - 1 degree of freedom: force and kinematic excitation, state space, damped and undamped free oscillations, Lehr's damping, phase space portraits, eigenvalue plots, harmonic excitation, amplitude and phase responses, power consumption, beat frequencies, resonance.
3. Linear oscillation - 1 degrees of freedom: MDGKN system, representation in configuration and state space, eigenvalues, eigenvectors, higher order eigenvectors, undamped and damped systems, Rayleigh damping, modal decoupling.
4. Wave equation: String under tension, longitudinal dynamics of rods, torsional vibrations of circular cylindrical rods, boundary conditions in space and time, canonical transformation, normal form of the wave equation, d’Alembert solution, characteristics, left and right waves, reflection at free and restrained ends, standing waves and oscillations.

Exercises
- Independent analysis of the basic geotechnical problems.
- Understanding of the important fundamental concepts of Soil mechanics and Geotechnical Engineering.
- Recognition of the basic consequences of ground construction.

Literature

Als Zusatzliteratur wird empfohlen: Mechanik 3, Dynamik, M.B. Sayir, Eigenverlag (CHF 32.-)

Examination Block 3

<table>
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<tr>
<th>Number</th>
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<tr>
<td>101-0315-00L</td>
<td>Geotechnical Engineering</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>A. Puzrin</td>
</tr>
</tbody>
</table>

Objective
- The course explores the fundamental principles of Geomechanics and Geotechnical Engineering, with the following objectives:
  - Recognition of the basic consequences of the ground construction;
  - Understanding of the important fundamental concepts of Soil mechanics and Geotechnical Engineering;
  - Independent analysis of the basic geotechnical problems.

Content
- Overview of stability problems; Bearing capacity of shallow and deep foundations; Soil-foundation interaction; Analysis and design of shallow and deep foundations; Earth pressure on retaining structures; Analysis and design of retaining walls; Excavations: dewatering, analysis and design; Safety considerations.

Literature


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0135-01L</td>
<td>Steel Structures II</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>R. Bärtschi</td>
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</tbody>
</table>

Abstract
- Theoretical basic knowledge and detailing of plate girders, trusses and composite beams and columns. Local load introduction, design structural analysis stability and detailing of buildings. A global approach including aspects of structural safety, architecture, use and durability is given. The course includes practical examples and exercises done by the students to enhance their knowledge.
Objective
Students know the theoretical basis and the detailing of strctural steel elements. They understand how to cope with local load introduction and redirection. They know the basics of design, detailing and dimensioning of steel structures for buildings, respecting aspects of safety, architecture, use, durability and flexibility etc.

Content
After having attended Steel structures I and II students are able to design, detail and dimension the structure of common steel buildings.

Basics of dimensioning of plate girders, trusses and composite beams and columns (structural modeling, detailing and selection of material). Load introduction and redirection, detailing. Design, detailing and dimensioning of steel and steel concrete composite structures including roof and façades. Interaction of different building elements including bracing and global stability of steel structures

Lecture notes
Autography on plate girders, trusses, load introduction and redirection, steel concrete composite elements. Copies of presentations.

Literature
Dubas, P.; Gehri, E.; Stahlhochbau, Springer-Verlag Berlin, 1988
- Stahlbaukalender, Ernst & Sohn, Berlin

Prerequisites / notice
The content of steel structures I is a prerequisite

101-0415-01L Railway Infrastructures (Transportation II) O 3 credits 2G U. A. Weidmann

Abstract
Fundamentals of railroad technology and interactions between track and vehicles, network development and infrastructure planning, planning of rail infrastructure, planning and design of railway stations, construction and dimensioning of tracks, approval and beginning service on complex infrastructure facilities, special issues of maintenance.

Objective
Teaches the basic principles of public transport network and topology design, geometrical design, dimensioning and construction as well as the maintenance of rail infrastructures. Teaches students to recognize the interactions between the infrastructure design and the production processes. Provides the background for Masters degree study.

Content
(1) Fundamentals of public transport systems; interaction between track and vehicles; passengers and goods as infrastructure users; management and financing of networks; railway standards and norms. (2) Infrastructure planning: Planning processes and decision levels in network development and infrastructure planning, planning of railway tracks and rail topologies; planning of the passenger parts of stations. (3) Infrastructure design: Fundamentals of the layout of a line: track geometry; switches and crossings; design of station platforms. (4) Construction of railway infrastructures: Assembly and evolution of the railway track; elements of the railway track; dimensioning of the track; track stability. (5) Approval and beginning service on complex infrastructure facilities: Definitions and limitations; fundamentals of the legal situation; test and approval processes; processes of putting railway systems into operation. (6) Maintenance of railway infrastructures: Fundamentals of infrastructure maintenance; kinds of deprevations; supervision methods; steps of maintenance infrastructure maintenance; estimation of maintenance need; methods to minimize maintenance costs.

Lecture notes
No remarks.

References to technical literature will be included in the course script. An additional list of literature will be provided during the course.

101-0515-00L Project Management O 2 credits 2G M. Kersting

Abstract
General introduction to the development, the life cycle and the characteristics of projects. Introduction to, and experience with, the methods and tools to help with the preparation, evaluation, organisation, planning, controlling and completion of projects.

Objective
To introduce the methods and tools of project management. To impart knowledge in the areas of project organisation and structure, project planning, resource management, project controlling and on team leadership and team work.

Content
- From strategic planning to implementation (Project phases, goals, constraints, and feasibility)
- Project leadership (Leadership, Teams)
- Project organization (Structure)
- Project planning (Schedule, cost and resource planning)
- Project controlling
- Risk and Quality Management
- Project completion

Lecture notes
Yes

The transparencies will be available for download from the website at least one week before each class. Copies of all necessary documents will be distributed at appropriate times.

101-0325-01L Rock Mechanics O 2 credits 2G G. Anagnostou

Abstract
Introduction to the principles of rock mechanics. Fundamentals of engineering of structures built on rock.

Objective
Introduction to the principles of rock mechanics. Fundamentals of engineering of structures built on rock.

Content
Grundphänomene und Problemlustellungen des Felsbaus über Tage und des Untertagbaus im Fels; Felsstruktur; Erfassung des Kräftespiel; Verformungs- und Festigkeitseigenschaften von Gestein; Stabilität von Felsböschungen und Felsfundationen; Feldversuche und Feldmessungen.

Lecture notes
Autographie

Literature
Empfehlungen

Exam Block 4

Number Title Type ECTS Hours Lecturers
101-0125-00L Structural Concrete I O 5 credits 4G W. Kaufmann

Abstract
Contents: Introduction, historical development of structural concrete, materials and material behaviour (cement, concrete, reinforcing steel, prestressing steel), linear members (axial force, flexure and axial force, compression members and columns, shear, bending and shear, torsion and combined actions), strut-and-tie models and simple stress fields, detailing.

Objective
Knowing the materials concrete and reinforcing steel and understanding their interaction; Understanding the response of typical structural members; Knowing elementary models and ability to apply them to practical problems; Ability to correctly dimension and simple detail structures.

Content
Introduction, historical development of structural concrete, materials and material behaviour (cement, concrete, reinforcing steel, prestressing steel), linear members (axial force, flexure and axial force, compression members and columns, shear, bending and shear, torsion and combined actions), strut-and-tie models and simple stress fields, detailing.

Lecture notes

- SIA Codes 260 (Basis of structural design), 261 (Actions on structures) and 262 (concrete structures).

Prerequisites / notice
Prerequisites: "Theory of Structures I" and "Theory of Structures II".
Additional Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0615-00L</td>
<td>Materials III</td>
<td>O</td>
<td>5 credits</td>
<td>4P</td>
<td>R. J. Flatt, I. Burgert, P. Lura, H. Richner, F. Wittel</td>
</tr>
</tbody>
</table>

Abstract
Introduction into the basic and practical knowledge of important building materials and testing methods.

Objective
Introduction into the basic and practical knowledge of important building materials and testing methods.

Content
- Introduction of material testing equipment, with various examples of experiments on metals (tensile behaviour, hardness, bending and impact loading).
- Theoretical background and practical aspects of concrete technology: mixture design, casting and setting; determination of mechanical properties.
- Understanding the characteristic properties of wood: anisotropy, hygroscopic behaviour, shrinkage and swelling, and effect of size on strength. Introduction to test-methods for wood and wood-products.
- Introduction into the basics of scanning electron microscopy: practical exercises with the Environmental Scanning Electron Microscope (ESEM).
- Introduction to fundamentals of Finite Element Methods and their application in examples.
- Introduction to durability of building materials and building structures: assessment of potentials for detecting and locating corrosion of steel reinforcement in concrete.

Lecture notes
For each topic a script will be provided, that can be downloaded under www.ifb.ethz.ch/education

Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0006-00L</td>
<td>Bachelor’s Thesis</td>
<td>O</td>
<td>10 credits</td>
<td>20D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

Objective
Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

Content
The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Electives of Bachelor Programme

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0185-01L</td>
<td>CAD for Civil Engineers</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>T. Vogel, K.H. Hamel</td>
</tr>
</tbody>
</table>

Abstract
Introduction to computer aided design and drafting in 2D and 3D with examples from structural engineering

Objective
Having followed the course, students are able to develop a 2D-structure (formwork drawing) and they know the principle of a reinforcement module. They have also got an introduction to a 3D program (reinforcement in 3D).
- They are therefore better prepared for:
  - the bachelor thesis in the 6th semester,
  - an eventual internship between bachelor and master course,
  - the master thesis.
  - the project works in the master course,
  - the master thesis.

Above all they practice spatial sense and acquire contextual knowledge as future superiors of draftsmen and designers.

Lecture notes
CAD für Bauingenieure

Prerequisites / notice
Spezialbewilligung der Dozierenden notwendig.
Für Studierende im 5. Semester während 10 Wochen gemäss speziellem Programm; Arbeit ausschliesslich am eigenen Laptop. Die rechtzeitige Installation der Software ist Bedingung für die Teilnahme. Eine Anleitung zur Installation wird ausgegeben.

Electives Courses ETH Zurich

Course Catalogue of ETH Zurich

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-BAUG.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Civil Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Eligibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
</tr>
</tbody>
</table>
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
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</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Major Courses

Major in Construction and Maintenance Management

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
101-0517-00L | Project Management: Pre-tender to Contract Execution | W+ | 3 credits | 2G | to be announced

Abstract: This course provides an introduction to:
- how to model the changes in infrastructure objects over time,
- how to monitor these changes and assess the benefits of monitoring,
- how to intervene to improve infrastructure performance and assess the benefits of interventions, and
- how to model the changes in stakeholders interests over time.

Objective: to provide the basic information and tools to be used to make decisions with respect to existing infrastructure.
Abstract
This course will provide a comprehensive overview and understanding of the techniques, processes, tools and terminology to manage the Project Triangle (time, cost, quality) and to organize, analyze, control and report a complex project from Pre-Tender stage to Contract signature and Notice to Proceed. This is part 1 of a 3 part course, see notice below.

Objective
Upon successful completion of this course students will have the understanding of the Project Management duties and responsibilities from the Pre-Tender stage of a project to Contract Execution.

Content
- Project scope definition and project organization
- Technical specification proposals
- Work Breakdown Structure
- Estimating
- Schedule development
- Interface management
- Resource and cost integration
- Risk and opportunity identification and quantification
- Contract review and analysis
- Project life cycle
- Contract Execution - Project Manager Check List

Lecture notes
The slides will either be distributed at the beginning of the class, or made available online (via Moodle) prior to class. A copy of the appropriate chapter of the script, the assignment and any other assigned reading materials will be available via Moodle.

Literature
Appropriate reading material (e.g., chapters out of certain textbooks or trade articles) will be assigned when necessary and made available via Moodle.

Prerequisites / notice
This is part 1 of a 3 part course. Part 2 will take the student through Project Execution of complex Projects. Part 3 will take the student through advanced topics in Project Management.

The students will be randomly assigned to teams of 3 max. Students will be graded as a team based on the Project Proposal report and the in-class oral presentation of the Project Proposal. The Project Proposal will consist of an accumulation of the homework assignments.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>066-0415-00L</td>
<td>Building Physics: Theory and Applications</td>
<td>4</td>
<td>W</td>
<td>3V+1U</td>
</tr>
<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>4</td>
<td>W</td>
<td>3G</td>
</tr>
<tr>
<td>066-0427-00L</td>
<td>Design and Building Process MBS</td>
<td>2</td>
<td>W</td>
<td>2V</td>
</tr>
<tr>
<td>101-0427-01L</td>
<td>System and Network Planning</td>
<td>6</td>
<td>W</td>
<td>4G</td>
</tr>
</tbody>
</table>

Abstract
Principles of heat and mass transport, hygro-thermal performance, durability of the building envelope and interaction with indoor and outdoor climates, applications.

Objective
The students will acquire in the following fields:
- Principles of heat and mass transport and their mathematical description.
- Indoor and outdoor climate and driving forces.
- Hygrothermal properties of building materials.
- Building envelope solutions and their construction.
- Hygrothermal performance and durability.

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity), solar chemistry, geothermal-energy, energy from waste, CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Abstract

Literature

Prerequisites / notice
Fundamentals of chemistry and physics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

Abstract
Lectures on twelve compact aspects gaining importance in an increasingly specialised, complex and international surrounding: Topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade and getting started.

Objective
“Design and Building Process MBS” is a brief manual covering the competencies and the responsibilities of all involved parties through the design and building process. Lectures on the topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship.

Content
“Design and Building Process MBS” is a brief manual covering the competencies and the responsibilities of involved parties through the design and building process. Twelve compact aspects regarding the establish building culture are gaining importance in an increasingly specialised, complex and international surrounding. Lectures on the topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship. The course introduces the key figures, depicts the measurable and non-measurable criteria of the project and highlights the provided services of the consultants. In addition to discussing the basics, the terminologies and the tendencies, the lecture units will refer to the studies as well as the prctice: Teaching-based case studies will compliment and deepen the understanding of the twelve selected aspects. The course is presented as a moderated seminar to allow students the opportunity for individual input: active collaboration between the students and their tutor therefore required.

Abstract
Public transports in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile via Mobility.

Objective
Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them.
(1) Fundamentals of system and network planning: Mobility and transport systems; public transport systems; customer needs versus supply characteristics of regular services. (2) System and network planning in public passenger services: Goals of the system and network planning; generic planning process; demarcation, analysis of the situation, setting of targets; design of public transport services; evaluation and optimization; system planning. (3) Public transport services: long distance service offers; suburban and urban service offers; regional and local service offers; access to public transport and the last mile.

A script in German will be provided for the course. The slides are made available.

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

# Major in Geotechnical Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0317-00L</td>
<td>Tunnelling I</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Anagnostou, E. Pimentel</td>
</tr>
<tr>
<td>101-0357-00L</td>
<td>Theoretical and Experimental Soil Mechanics</td>
<td>W+</td>
<td>6 credits</td>
<td>4G</td>
<td>R. Herzog, S. M. Springman</td>
</tr>
<tr>
<td>101-0307-00L</td>
<td>Design and Construction in Geotechnical Engineering</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Thielen, P. A. Mayor</td>
</tr>
</tbody>
</table>

### Overview of soil behaviour

- Basic aspects of design and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement). Numerical analysis methods.

### Literature

- Autographieblätter
- Empfehlungen

- The number of participants is limited to 30 due to the existing laboratory equipment! Students with major in Geotechnical Engineering have priority. Registrations will be accepted in the order they are received.

- The basics of planning and design of geotechnical structures will be taught for the main topics geotechnical engineers are faced to in practice.

- Pre-requirements: Basic knowledge in soil mechanics as well as knowledge of advanced mechanics

- Laboratory equipment will be available for 60 students. First priority goes to those registered for the geotechnics specialty in the Masters, 2nd year students then first year students, doctoral students qualifying officially for their PhD status and then 'first come, first served'.

- The number of participants is limited to 30 due to the existing laboratory equipment! Students with major in Geotechnical Engineering have priority. Registrations will be accepted in the order they are received.

- Geotechnical Engineering have priority. Registrations will be accepted in the order they are received.

- The number of participants is limited to 30 due to the existing laboratory equipment! Students with major in Geotechnical Engineering have priority. Registrations will be accepted in the order they are received.
### Major in Structural Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0117-00L</td>
<td>Structural Analysis III</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>D. Heinzmann, S. Zweidler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Enhanced understanding of the load-deformation response of beam and frame structures. Systematic treatment of elementary and combined load carrying mechanisms of elastic beams, cables, arches and rings.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Enhanced understanding of the load-deformation response of beam and frame structures. Systematic treatment of elementary and combined load carrying mechanisms of elastic beams, cables, arches and rings.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Axially loaded members, shear deformation of girders, torsion, beams, cables, arches and rings, shear walls and frames, combined cable and flexural action.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0137-00L</td>
<td>Steel Structures III</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Knobloch</td>
</tr>
<tr>
<td>Abstract</td>
<td>Enhance theoretical considerations and detailing of structural steel design including aspects of economy and erection. E.g. Cranes, composite construction (compression and bending, continuous girders, partial connection, serviceability), fire design, stability of frames and buckling of plates with stiffeners, cold rolled sections, corrosion protection, price calculation and quality control</td>
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</tr>
<tr>
<td>Objective</td>
<td>Enhance theoretical considerations and detailing of structural steel design including aspects of economy and erection.</td>
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</tr>
<tr>
<td>Content</td>
<td>Constructive design of cranes, composite construction (compression and bending, continuous girders, partial connection, serviceability), fire design, stability of frames and buckling of plates with stiffeners, cold rolled sections, corrosion protection, price calculation and quality control</td>
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<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Autography</td>
<td></td>
<td></td>
<td></td>
<td>Copies of presentations</td>
</tr>
<tr>
<td>- Stahlbauhandbuch 1 und 2, Stahlbau-Verlags-GmbH, Köln</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Stahlbaukalender 2000, Ernst + Sohn, Berlin, 1999</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Steel Structures I and II</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0187-00L</td>
<td>Structural Reliability and Risk Analysis</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>B. Sudret</td>
</tr>
<tr>
<td>Abstract</td>
<td>Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.</td>
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</tbody>
</table>

Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro- codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FORM) and the first order reliability method (FOSM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented. Bayesian networks are introduced as a generic numerical tool for solving such problems. The course also includes a tutorial using a software dedicated to real world structural reliability analysis.

This is a course on structural dynamics, an extension of structural analysis for loads that induce significant inertial forces and vibratory response. Dynamic responses of elastic and inelastic single-degree-of-freedom, continuous-mass and multiple-degree-of-freedom structural systems are introduced as a generic numerical tool for solving such problems. The course also includes a tutorial using a software dedicated to real world structural reliability analysis.

The lecture’s target is the knowledge of the physical basics and technical components of relevant systems for a efficient and sustainable construction. Based on EK I, the EK II lectures focus on all possible systems and concepts available to the architect for a sustainable design.

The EK I lectures focus on technical components in use as well as their rough calculation methods and their integration into design and construction. Based on EK I, the EK II lectures focus on all possible systems and concepts available to the architect for a sustainable design.

EK I lectures focus on technical components in use as well as their rough calculation methods and their integration into design and construction.

Based on EK I, the EK II lectures focus on all possible systems and concepts available to the architect for a sustainable design.

The Slides from the lecture serve as lecture notes and are available as download.

A bibliography will be distributed at the beginning of the lecture.

The electronic copies of the learning material will be uploaded to ILIAS and available through myStudies. The learning material includes: the lecture presentations, additional reading material, and exercise problems and solutions.
Content

1. Introduction
   Moisture damage: problem statement
   Durability

2. Moisture Transport
   Description of moisture transport
   Determination of moisture transport properties
   Hysteresis
   Transport in cracked materials
   Damage and moisture transport in cracked media

3. Poromechanics
   Moisture and mechanics: poro-elasticity
   Poro-elasticity and salt crystallisation
   Poro-elasticity and damage
   Case studies

4. Multiscale analysis
   Problem statement
   Multiscale transport model
   Multiscale coupled transport - damage model

101-0167-01L Fibre Composite Materials in Structural Engineering W 3 credits 2G M. Motavalli

Abstract
1) Lamina and Laminate Theory
2) FRP Manufacturing and Testing Methods
3) Design and Application of Externally Bonded Reinforcement to Concrete, Timber, Masonry, and metallic Structures
4) FRP Reinforced Concrete, All FRP Structures
5) Measurement Techniques and Structural Health Monitoring

Objective
At the end of the course, you shall be able to

1) Design advanced FRP composites for your structures,
2) To consult owners and clients with necessary testing and SHM techniques for FRP structures,
3) Continue your education as a PhD student in this field.

Content
Fibre Reinforced Polymer (FRP) composites are increasingly being used in civil infrastructure applications, such as reinforcing rods, tendons and FRP profiles as well as wraps for seismic upgrading of columns and repair of deteriorated structures. The objective of this course is on one hand to provide new generation of engineering students with an overall awareness of the application and design of FRP reinforcing materials for internal and external strengthening (repair) of reinforced concrete structures. The FRP strengthening of other structures such as metallic, timber and masonry will also be shortly discussed. On the other hand the course will provide guidance to students seeking additional information on the topic. Many practical cases will be presented analysed and discussed. An ongoing structural health monitoring of these new materials is necessary to ensure that the structures are performing as planned, and that the safety and integrity of structures is not compromised. The course outlines some of the primary considerations to keep in mind when designing and utilizing structural health monitoring technologies. During the course, students will have the opportunity to design FRP strengthened concrete beams, apply the FRP by themselves, and finally test their samples up to failure.

Lecture notes
1) Power Point Printouts
2) Handouts

Literature
2) fib bulletin 14, Externally Bonded FRP Reinforcement for RC Structures, 2001
3) ISIS Canada Short Courses, http://www.isiscanada.com/
5) Measurement Techniques and Structural Health Monitoring

Prerequisites / notice
1) Laboratory Tours and Demonstrations: Empa Structural Engineering Laboratory including Empa FRP Footbridge, Smart Composites, Large Scale Testing of Structural Components
2) Working with Composite Materials in the Laboratory (application, testing, etc)

Major in Transport Systems

Number Title Type ECTS Hours Lecturers
101-0427-01L System and Network Planning O 6 credits 4G U. A. Weidmann

Abstract
Public transports in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile

Objective
Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them

Content
1) Fundamentals of system and network planning: Mobility and transport systems; public transport systems; customer needs versus supply characteristics of regular services. (2) System and network planning in public passenger services: Goals of the system and network planning; generic planning process; demarcation, analysis of the situation, setting of targets; design of public transport services; evaluation and optimization; system planning. (3) Public transport services: long distance service offers; suburban and urban service offers; regional and local service offers; access to public transport and the last mile.

Lecture notes
A script in German will be provided for the course. The slides are made available.

Literature
References to technical literature will be included in the course script. An additional list of literature will be given during the course.

No remarks.

101-0437-00L Traffic Engineering O 6 credits 4G M. Menendez

Abstract
Fundamentals of traffic flow theory and operations.

Objective
The objective of this course is to fully understand the fundamentals of traffic flow theory in order to effectively manage traffic operations. By the end of this course students should be able to apply basic techniques to model different aspects of urban and inter-urban traffic performance, including congestion.

Content
Introduction to fundamentals of traffic flow theory and operations. Includes understanding of traffic data collection and processing techniques, as well as data analysis, and traffic modeling.

Lecture notes
The lecture notes and additional handouts will be provided during the lectures.
**Basics in Air Transport**

Content
- Understand and explain basics, principles and contexts in the broader air transport industry.

Objective
- Lay the foundation of working in or with the air transport industry.

**Sustainable Spatial Development I**

Content
- Tasks of Spatial Planning and development
- Issues of local and supra-local interest
- Recurring spatial changes, impacts and key figures
- Formal and informal instruments and procedures in spatial planning
- Spatial Design - Ideas about the future
- Reasoning and assessing the situation in spatial planning
- Spatial planning as a sequence of decisions and interventions
- Process and procedures management
- Focus issues - Inner development before external development
- Focus issues - Cross-border tasks
- Focus Issues - Integrated spatial and infrastructure development

Objective
- Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation.

**Introduction to Mathematical Optimization**

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

Literature

**Transport Planning Methods**

Abstract
- The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems.
- The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.

Objective
- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

Content
- The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

Lecture notes
- The slides of the lecture are provided electronically.

**Introduction to Mathematical Optimization**

Abstract
- Introduction to basic techniques and problems of mathematical optimization.

Objective
- The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

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

Literature
- Information about relevant literature will be given in the lecture.

**Basics in Air Transport**

Abstract

Objective
- The course explains main principles of air transport in general and elaborates on simple interdisciplinary topics.

Since working on broad topics like aerodynamics, manufacturers, airport operation, business aviation, business models etc. the students gets a good overview in air Transportation.

Objective
- Understand and explain basics, principles and contexts in the broader air transport industry.

Lecture notes
- Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.
In the course Numerical Hydraulics the basics of numerical modelling of flows are presented. The course is given in English. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated. All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

### Content

Weekly: 1h independent preparation; 2h lectures and 1 h training with an expert in the respective field

#### Concept:
This course will be taught as Aviation I. A subsequent course is under evaluation.

#### Literature:
Guided tour: This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

#### Prerequisites / notice:

- Examination: written,60 min, with open book
- Literature will be provided by the lecturers respective there will be additional Information upon registration
- We will also use English papers

#### Major in Hydraulic Engineering and Water Resources Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0247-01L</td>
<td>Hydraulic Engineering II</td>
<td>O</td>
<td>6 credits</td>
<td>4G</td>
<td>R. Boes</td>
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<tr>
<td></td>
<td>Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).</td>
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<tr>
<td>Abstract</td>
<td>Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety.</td>
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<tr>
<td>Lecture notes</td>
<td>Manuscript and further documentation is specified in the lecture and in the manuscript</td>
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<tr>
<td>Literature</td>
<td>Numerical Hydraulics is not recommended without having attended Hydraulic Engineering II (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).</td>
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<tr>
<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Holzer</td>
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<tr>
<td></td>
<td>In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.</td>
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<tr>
<td>Abstract</td>
<td>The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.</td>
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<tr>
<td>Objective</td>
<td>The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated. All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.</td>
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<tr>
<td>Content</td>
<td>All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.</td>
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<td>Lecture notes</td>
<td>Manuscript and further documentation is specified in the lecture and in the manuscript</td>
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</tr>
<tr>
<td>Literature</td>
<td>Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.</td>
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<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando, S. Fatici</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.</td>
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<tr>
<td>Objective</td>
<td>Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.</td>
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<tr>
<td>Lecture notes</td>
<td>Parts of the script for &quot;Hydrology II&quot; are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.</td>
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<tr>
<td>Literature</td>
<td>Additional literature is presented during the course.</td>
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<tr>
<td>102-0455-01L</td>
<td>Groundwater I</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Willmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction into quantitavie analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.</td>
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<tr>
<td>Objective</td>
<td>a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater. b) Students are able to formulate simple practical flow and transport problems. c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems. d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.</td>
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</tbody>
</table>
Content

- Introduction, aquifers, groundwater use, sustainability, porosity.
- Properties of porous media.
- Experiments: Groundwater use, porosity, grain size analysis.
- Flow properties, Darcy’s law, filter.
- Flow equations, stream function.
- Experiments: Darcy’s law.
- Analytical solutions, confined aquifers, steady-state flow.
- Experiments: Analytical solutions to flow problems.
- Finite difference solutions to flow problems I.
- Experiments: Analytical solutions to flow problems.
- Finite difference solutions to flow problems II.
- Experiments: Finite difference formulations to flow problems.
- Transport processes.
- Experiments: Computer workshop using PMWIN.
- Analytical solutions to transport problems I.
- Experiments: Computer workshop using PMWIN.
- Analytical solutions to transport problems II.
- Experiments: Analytical solutions to transport problems.
- Path lines, groundwater protection.
- Experiments: Analytical solutions to transport problems.
- Groundwater remediation, groundwater management.
- Experiments: Groundwater remediation.

Lecture notes

Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index
Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature

- W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
- G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

River Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0258-00L</td>
<td>River Engineering</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>G. R. Bezzola</td>
</tr>
</tbody>
</table>

Abstract

- The students shall
  - be able to describe quantitatively the interrelation between discharge, sediment transport and channel evolution
  - know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration

Literature

The autography contains a comprehensive list of references to relevant literature.  
strongly recommended:
Hydrology, Hydraulics I and Hydraulic Engineering

Prerequisites / notice

The voluntary and unmarked exercise bases on field data, which are collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges at the onset of bed load transport and bed erosion and of the annual sediment load in a given river reach.

Major in Materials and Mechanics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0617-00L</td>
<td>Materials IV</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>H. J. Herrmann, I. Burgert, R. J. Flatt, F. Wittel</td>
</tr>
</tbody>
</table>

Abstract

This lecture is focused on current issues of materials research from various fields. It provides an overview on various directions of research on civil engineering materials and is intended to simplify the further choice of courses.
Objective

Based on the bachelor courses Materials I-III, current, fundamental, and important issues of specific building materials are addressed. Next to aspects of material production, usage and properties, their interaction with the environment e.g. by durability and environmental impact are addressed. This course is intended to simplify the further selection of courses.

Content

The lecture is segmented into 13 important problems, namely:

1. Materials, Structures, and Sustainability
2. Granular matter: (DEM)
3. Fracture mechanics and size effects in concrete
4. Cyclic failure of asphalt (Fatigue)
5. Mechanics and failure of fiber reinforces materials
6. Wood: from the tree to the beam (multi scale approaches)
7. Transport and degradation in porous building materials
8. Rheology
9. Plasticity
10. Foam (e.g. polymers)
11. Gluing and coating (surfaces)
12. Asbestos, nano particles and hazardous substances
13. Biomimetics in Constructions

Lecture notes

download from www.ifb.ethz.ch/education

Literature

download from www.ifb.ethz.ch/education

Prerequisites /

The lecture will be given in english.

<table>
<thead>
<tr>
<th>Course ID</th>
<th>Course Name</th>
<th>Credits</th>
<th>SEM</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0809-01L</td>
<td>Introduction to Computational Physics (for Civil Engineers)</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>H. J. Herrmann</td>
</tr>
<tr>
<td>101-0537-01L</td>
<td>Wood and Wood Composites</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Frangl, I. Burgert, G. Fink, M. Fontana, R. Steiger</td>
</tr>
<tr>
<td>101-0677-00L</td>
<td>Concrete Technology</td>
<td>2 credits</td>
<td>2G</td>
<td>G. Martinola, M. Bäuml</td>
</tr>
<tr>
<td>101-0177-00L</td>
<td>Building Physics: Moisture and Durability</td>
<td>3 credits</td>
<td>2G</td>
<td>J. Carmeliet, T. Defraeye</td>
</tr>
</tbody>
</table>
Abstract
Moisture transport and related degradation processes in building and civil engineering materials and structures; concepts of poromechanics and multiscale analysis; analysis of damage cases.

Objective
- Basic knowledge of moisture transport and related degradation processes in building and civil engineering materials and structures
- Introduction to concepts of poromechanics and multiscale analysis
- Application of knowledge by the analysis of damage cases

Content
1. Introduction
   Moisture damage: problem statement
   Durability

2. Moisture Transport
   Description of moisture transport
   Determination of moisture transport properties
   Hysteresis
   Transport in cracked materials
   Damage and moisture transport in cracked media

3. Poromechanics
   Moisture and mechanics: poro-elasticity
   Poro-elasticity and salt crystallisation
   Poro-elasticity and damage
   Case studies

4. Multiscale analysis
   Problem statement
   Multiscale transport model
   Multiscale coupled transport - damage model

Literature
Donald R. Askeland, Materialwissenschaften, Spektrum Akademischer Verlag, Heidelberg (1996)

Kapitel 1 - 13

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3. Semester

Major Courses

Major in Construction and Maintenance Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0509-00L</td>
<td>Infrastructure Management Systems</td>
<td>W+</td>
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<td>2G</td>
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<td></td>
<td>The course will provide an introduction to the human and computerized systems used to manage infrastructure.</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>Upon completion of the course students will have the fundamental knowledge required</td>
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<td>- to identify and model the processes used in organizations to manage infrastructures</td>
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<td>- to establish benchmarks that can be used to measure the performance of organizations that manage infrastructure, and</td>
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<td>- to evaluate organizations that manage infrastructure</td>
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<tr>
<td></td>
<td>Content</td>
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<td></td>
<td>- Introduction</td>
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<td></td>
<td>- Organisation types used to manage infrastructure</td>
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<td>- Processes used in organizations that manage infrastructure</td>
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<td>- Methods used to evaluate organizations that manage infrastructure, including the establishment of appropriate benchmarks</td>
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<td></td>
<td>Lecture notes</td>
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<tr>
<td></td>
<td>Lecture notes (in german) are distributed at the beginning of the course.</td>
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<tr>
<td></td>
<td>Reprints for selected topics.</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>Donald R. Askeland, Materialwissenschaften, Spektrum Akademischer Verlag, Heidelberg (1996)</td>
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<td>ISBN 3-86025-357-3</td>
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<td>Kapitel 1 - 13</td>
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Autumn Semester 2015
### 101-0577-00L An Introduction to Sustainable Development in the Built Environment

**Abstract**
This course provides an introduction to the notion of sustainable development when applied to our built environment.

**Objective**
At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmentmetal aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

**Content**
The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

**Lecture notes**
The slides from the presentations will be made available.

**Literature**
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

### 101-0587-00L Workshop on Sustainable Building Certification

**Abstract**
Building labels are used to certify buildings and neighbourhoods in term of sustainability. Many different labels have been developed and can be used in Switzerland (LEED, DGNB, SNBS, Minergie). In this course the differences between the certification labels and its application on 3 emblematic case study buildings will be discussed.

**Objective**
After this course, the students are able to understand and use the different certification labels. They have a clear view of what the labels take into consideration and what they don't.

**Content**
Three buildings case study will be presented.

Different certification schemes, including LEED (American standard), DGNB (German Standard with Swiss adaptation), SNBS, MINERGIE-ECO and 2000-Watt-Society (Swiss standards) will be presented and explained by experts.

After this overall general presentation and in order to have a closer look to specific aspects of sustainability, students will work in groups and assess during one or two weeks this specific criteria on one of the case studies presented before. This practical hands on the label will end with a presentation and a discussion where we will highlight differences between the labels.

This alternance of working session on one specific criteria for one specific building followed by a group presentation and discussion to compare labels is repeated for the different focus point (operation energy, mobility, daylight, indoor air quality).

**Lecture notes**
The slides from the presentations will be made available.

**Literature**
All documents for certification labels as well as detail plans of the buildings will be available for the students.

### 101-0439-00L Introduction to Economic Policy - A Case Study Approach with Cost Benefit Analysis in Transport

**Abstract**
The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.

**Objective**
Familiarity with the essential methods of project appraisal

**Content**
Cost-Benefit-Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety

**Lecture notes**
Handouts
Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods.

Abstract

Objective

Content

Lecture notes

Literature

Prerequisites / notice

The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forecast are shown. State-of-the-art maintenance strategies and technologies are presented.

Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods.

The slides will be made available.

A list with related technical literature will be handed out.

The lecture Railway Infrastructures (Transportation II) is recommended.

The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forecast are shown. State-of-the-art maintenance strategies and technologies are presented.

Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods.

The slides will be made available.

A list with related technical literature will be handed out.

The lecture Railway Infrastructures (Transportation II) is recommended.

### Major in Geotechnical Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0329-00L</td>
<td>Environmental Geotechnics</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>L. M. Plötze</td>
</tr>
<tr>
<td>101-0359-00L</td>
<td>Physical Modelling in Geotechnics</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>to be announced</td>
</tr>
</tbody>
</table>

### Tunnelling III

- **Abstract**: Deepen the knowledge on selected topics of underground construction as well as learning working out conceptual solutions of complex problems.
- **Objective**: Lecture: Deepen the knowledge on selected topics of underground construction. Exercises: Conceptual solutions of complex problems.
- **Content**: Caverns; Geometry, construction methods, support. Shafts: Construction methods, support. Urban tunnelling: Boundary conditions, system choice, alignment, design. Field measurements: Principles, monitoring layout, applications, interpretation. Cut and cover tunnels: Modelling, design. Exercising conceptual solution of complex tunnelling problems based upon discussion of current tunnel cases with particularly demanding problems in small groups.

### Environmental Geotechnics

- **Abstract**: Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems. Introduction in landfill design and engineering with focus on barrier- and drainage systems and lining materials, evaluation of geotechnical problems, e.g. stability.
- **Objective**: Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems. Introduction in landfill design and engineering with focus on barrier- and drainage systems as well as lining materials, evaluation of geotechnical problems, e.g. stability.
- **Content**: Definition of contaminated sites, site investigation methods, historical research and technical investigation, risk assessment, contamination transport, remediation, clean-up and retaining techniques (e.g. bioremediation, incineration, retaining walls, pump-and-treat, permeable reactive barriers), monitoring, research projects and results.

### Physical Modelling in Geotechnics

- **Abstract**: Aspects of both physical modelling in geotechnical engineering complemented by application of numerical modelling; appreciation of typical mechanisms pertaining to ultimate & serviceability limit state; influence on resulting design methods.
- **Objective**: Leading to an appreciation of the typical mechanisms pertaining to ultimate & serviceability limit state influence on resulting design methods.
- **Content**: Principles of physical modelling: Centrifuge (physics, scaling laws, errors) Experimental methods: Geotechnical (sand/clay model making, site investigation), mechanical (packages, actuators), electronic (data acquisition) Application of physical modelling for typical geotechnical problems, validated or calibrated by finite element analysis (learnt and applied in an earlier course). Review of mechanisms observed, comparison between modelling, numerical and/or classical plasticity methods, implications for design.

### Literature

- **Literature**
  - Lectures notes: Autographieblätter
  - Literature: Empfehlungen
  - Prerequisites / notice: Prerequisite: BSc course “Tunnelling”, MSc courses “Tunnelling I” and “Tunnelling II”.

### Excursion

- **Dr. R. Hermanns Stengele, Dr. M. Plötze: Environmental Geotechnics (german)**

### Exercises

- **Excercises: Conceptual solutions of complex problems.**

### References

A simple soil structure interaction boundary value problem will be selected (e.g., foundation, embankment, slope) as the exercise topic, which will be modeled in various forms, throughout the course. A predictive (class A) numerical analysis will be carried out by the students, followed by a centrifuge test on the same geometry to validate the numerical calculations. Subsequently a Class C2 numerical analysis will be conducted, calibrated by the physical modelling event.

101-0369-00L  Forensic Geotechnical Engineering  W  3 credits  2G  A. Puzrin

Prerequisites / notice

In this course selected famous geotechnical failures are investigated with the following purpose: (a) to deepen understanding of the geotechnical risks and possible solutions; (b) to practice design and analysis methods; (c) to learn the techniques for investigation of failures; (d) to learn the techniques for mitigation of the failure damage.

Objective

In this course selected famous geotechnical failures are investigated with the following purpose: (a) to deepen understanding of the geotechnical risks and possible solutions; (b) to practice design and analysis methods; (c) to learn the techniques for investigation of failures; (d) to learn the techniques for mitigation of the failure damage.

Content

Failure of shallow and deep foundations
Failure due to the creeping landslides
Failure due to excessive settlements
Failure due to the leaning instability
Failure due to tunnelling
Excavation failure

Lecture notes

Lecture notes

Literature


Prerequisites / notice

Prerequisite: Basic knowledge in Geotechnical Engineering (Course content of "Grundbau" or similar lecture.)

101-0119-00L  Structural Masonry  W  3 credits  2G  N. Mojsilovic

Abstract

Knowledge of the engineering properties of materials for masonry construction. Technical understanding of the structural behaviour of load-bearing masonry structures subjected to in-plane forces and combined actions. Develop a technical competence for design procedures for load-bearing masonry structures by means of exercises.

Objective

Knowledge of the engineering properties of materials for masonry construction. Technical understanding of the structural behaviour of load-bearing masonry structures subjected to in-plane forces and combined actions. Develop a technical competence for design procedures for load-bearing masonry structures by means of exercises.

Content

Historical Development of Masonry Construction
Detailing and Execution
Construction Materials
Structural Behaviour and Modelling
Structural Analysis and Dimensioning
Reinforced Masonry

Lecture notes

Lecture notes

Literature

"Mauerwerk, Bemessungsbeispiele zur Norm SIA 266", SIA Dokumentation D0196, 2004
"Mauerwerk", Norm SIA 266, 2003

Prerequisites / notice

Structural Concrete III

101-0129-00L  Existing Structures  W  3 credits  2G  T. Vogel

Abstract

Treatment of the topic primarily from the perspective of a consulting engineer dealing with a single object. Elaboration of a systematic procedure for respective projects. Consolidation for concrete structures and extension to other construction methods. Uncovering of interfaces between owners, architects, contractors and specialists.

Objective

Treatment of the topic primarily from the perspective of a consulting engineer dealing with a single object. Elaboration of a systematic procedure for respective projects. Consolidation for concrete structures and extension to other construction methods. Uncovering of interfaces between owners, architects, contractors and specialists.

Content

Systems of existing structures, examination (condition survey, condition examination, recommendation of remedial measures), non-destructive testing methods, natural stone masonry, strengthening methods (esp. plate bonding)

Lecture notes

Lecture notes

Literature

Normen SIA 269, 269/1 bis 269/6,
SIA-Dokumentationen D 0239 und D 0240 der Einführungskurse

101-0149-00L  Plate and Shell Structures  W  3 credits  2G  T. Vogel, S. Fricker

Abstract

Basic load bearing behaviour of plate and shell structures

Objective

Comprehension of basic load bearing behaviour of plate and shell structures; knowledge of typical applications of different materials, ability to reasonably interpret and check results of numerical calculations, establish access to technical literature.

Content

In-plane loaded plates (cartesian and polar coordinates)
Kinematics of in-plane loaded plates
Folded plate structures
Thin plates with small deflections
Circular plates
Thin plates with large deflections
Geometry of curved surfaces
Shells (basics, membrane theory, bending theory, form finding)

Lecture notes

Autographie "Flächentragwerke"
Method of Finite Elements II

Abstract
Basic theoretical and procedural concepts of the method of finite elements (FE) for the analysis of nonlinear & dynamic systems are introduced. Kinematic and material nonlinear effects and the dynamic analysis of structures in terms of modal and time domain analysis are described.

Objective
The course is complemented by Homework Sessions using computing tools and FE software such as MATLAB, ABAQUS & ANSYS.

Content
Introduction to finite element nonlinear analysis in structural engineering. Formulation and solution of nonlinear problems. Nonlinear constitutive relations. Dynamic finite element analysis. Solution of eigen value problems. Practical application of the finite element nonlinear and/or dynamic analysis

Lecture notes
Handouts, Course Script available on http://www.ibk.ethz.ch/ibk/ibk/ch/education/femII/index_EN

Literature
Course Script available on http://www.ibk.ethz.ch/ibk/ibk/ch/education/femII/index_EN

Useful Reading:

Seismic Design of Structures II

Abstract
The following advanced topics will be covered: 1) behavior and non-linear response of structural systems under earthquake excitation; 2) seismic behavior and design of moment frame, braced frame, shear wall and masonry structures; 3) fundamentals of seismic isolation; and 4) assessment and retrofit of existing buildings. These topics are discussed in terms of performance-based seismic design.

Objective
After successfully completing this course the students will be able to:
1. Use the knowledge of nonlinear dynamic response of structures to interpret the design code provisions and apply them in seismic design structural systems.
2. Explain the seismic behavior of moment frame, braced frame and shear wall structural systems and successfully design such systems to achieve the performance objectives stipulated by the design codes.
3. Determine the performance of structures under earthquake loading using modern performance assessment methods and analysis tools.

Content
This course completes the series of two courses on seismic design of structures at ETHZ. Building on the material covered in Seismic Design of Structures I, the following advanced topics will be covered in this course: 1) behavior and non-linear response of structural systems under earthquake excitation; 2) seismic behavior and design of moment frame, braced frame and shear wall structures; 3) fundamentals of seismic isolation; and 4) assessment and retrofit of existing buildings. These topics will be discussed from the standpoint of performance-based design.

Lecture notes
The electronic copies of the learning material will be uploaded to ILIAS and available through myStudies. The learning material includes the lecture presentations, additional reading, and exercise problems and solutions.

Literature
Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering, Yusef Borzorgnia and Vitelmo Bertero, Eds., CRC Press, 2004


Prerequisites / notice
ETH Seismic Design of Structures I course, or equivalent. Students are expected to understand the seismological nature of earthquakes, to characterize the ground motion excitation, to analyze the response of elastic single- and multiple-degree-of-freedom systems to earthquake excitation, to use the concept of response and design spectrum, to compute the equivalent seismic loads on simple structures, and to perform code-based seismic design of simple structures. Familiarly with structural analysis software, such as SAP2000, and general-purpose numerical analysis software, such as Matlab, is expected.

Introduction to Economic Policy - A Case Study Approach with Cost Benefit Analysis in Transport

Abstract
The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.
101-0469-00L  Road Safety  W  6 credits  4G  H. Schüller, A. Simma, S. Skeledzic
Abstract  The collection and the methods of statistical and geographical analysis of road accidents are important fundamentals of this course. Safety
Objective  Imparting knowledge about road safety and the event of accident, presenting possibilities to increase road safety
Content  Accident origin, collection of road accidents, statistical (descriptive and multivariate, accident prediction models) and geographical analysis
of road accidents, risk analysis and rehabilitation measures, road safety instruments for infrastructure with focus on road safety audit,
Swiss and international transport policy
Handbook of Road Safety Measures. Oxford: ELSEVIER Ltd.; EU-Projekt RiPCORD-iSEREST (http://ripcord.bast.de/)
Further literature: will be presented during the course

101-0419-00L  Railway Construction and Maintenance  W  4 credits  4G  U. A. Weidmann, P. Güldenapfel,
Abstract  Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle
tables, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track
Objective  The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and
dimensioning of the track. Methods for the diagnosis of the state of the track and its forecast are shown. State-of-the-art maintenance
Content  Track geometry including calculation and measuring as well related data systems; interaction between track and vehicles, vehicle
Abstract  dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track
Objective  maintenance and related methods
Content  Track geometry including calculation and measuring as well related data systems; interaction between track and vehicles, vehicle
dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track
maintenance and related methods
Literature  The slides will be made available.
Prerequisites / Lecture notes  A list with related technical literature will be handed out.
notice  The lecture Railway Infrastructures (Transportation II) is recommended.

101-0479-00L  Safety and Reliability of Railway Systems  W  3 credits  3G  U. A. Weidmann, O. Fink,
Abstract  Railway safety policies and safety concepts, command and control technologies for railways, optimization systems, European Train Control
System, reliability availability maintainability safety (RAMS) of railway systems.
Objective  The students comprehend the main principles of safety, reliability and optimization for railway systems and understand the basic concepts of
Content  Railway safety strategies
o Safety in public transport
o Safety relevant characteristic of railway transport
o Safety requirements for railway transport
o Safety concepts
Command and control technologies for railway systems
o protective functions
  o ensure the sequence/spacing of trains
  o ensure route protection
  o ensure level crossing protection
  o technical realization for protective functions
  o European Train Control System
  operational command/control systems
  o dispatching
  o operational control systems
  o concepts of optimization
  RAMS for railway systems
  o accident investigation methods
  o RAMS standards for railways
  o risk analysis and hazard control
  o RAMS methods
  o design principles for availability and safety
  o maintenance strategies
  o Life Cycle Costs (LCC)
  o Human Factor
  o safety in long railway tunnels

M. Montigel

Lecture notes  The slides will be provided in German.
Literature  References will be included in the lecture notes. An additional list of literature will be given during the course.
Prerequisites / Lecture notes  some of the tutorials will be held at the IVTs Railway Operation Laboratory. The lecture Systems Dimensioning and Capacity is
notice  recommended.

101-0449-00L  Management, Marketing, Quality  W  6 credits  4G  U. A. Weidmann
Abstract  Transport and administrative policy, international and national regulation, business management of public transport companies, marketing,
advertising and pricing; quality management
Objective
Comprehension of the transport and administrative policy as well as of the regulation of public transport companies. To develop a full understanding of the three important public transport system operations management processes: (1) Business management; (2) Marketing; (3) Quality control. The course will teach essential working techniques in each of these processes.

Content
(1) Transport and administrative policy: Goals of the state related to public transports, governmental activities in public transport, regulation.
(2) Business management in public transport enterprises: goals of public transport companies, goals of the business management, management of public transport on the different management levels, business organization.
(3) Marketing, advertising and pricing: Fundamentals and goals; marketing strategies and concepts in public transports; marketing tools; putting marketing into action.
(4) Quality control: Quality in transport systems; goals of quality management; structuring quality control measures; collecting quality data in an operating service; use of quality control systems for service optimization.

Lecture notes
Course notes will be provided in German. Slides will be made available.

Prerequisites / notice
Lectures System and Network Planning as well as Systems Dimensioning and Capacity recommended.

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
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<tr>
<td>101-0579-00L</td>
<td>Infrastructure Maintenance Processes</td>
<td>3</td>
<td>W</td>
<td>B. T. Adey</td>
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<tr>
<td>101-0579-00L</td>
<td>Infrastructure Management Systems</td>
<td>3</td>
<td>W</td>
<td>B. T. Adey</td>
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<tr>
<td>103-0417-02L</td>
<td>Theory and Methodology of Spatial Planning</td>
<td>3</td>
<td>W</td>
<td>R. Signer, M. Nollert</td>
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<td>101-0491-00L</td>
<td>Agent Based Modeling in Transportation</td>
<td>3</td>
<td>W</td>
<td>F. Ciari, R. Waraich</td>
</tr>
</tbody>
</table>
### Simulation of Traffic Operations

**Lecturers:** H. He

**ECTS:** 3 credits

**Prerequisites:** There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high-level programming language (i.e., C, C++, Fortran, or Java).

**Course Description:**

The course introduces basics of microscopic simulation of traffic operations, including simulation model development, calibration, validation, data analysis, identification of strategies for improving traffic performance, and evaluation of such strategies. The modelling software used is VISSIM.

**Specific tasks will include:**

1. Building a model with the simulator VISSIM in order to replicate and analyze the traffic conditions measured/observed.
2. Calibrating and validating the simulation model.
3. Redesigning/extend the model to improve the traffic performance.

**Additional literature recommendations:**

Additional literature recommendations will be provided at lectures.

**Lecture notes:**

Lecture notes and additional handouts will be provided before the lectures.

**Literature:**

Relevant books and citations will be mentioned throughout the course.

**Notice:**

There are no pre-requisites for this course. The course Transport Simulation (101-0438-00 G) and previous experience with VISSIM is helpful but not mandatory. In addition, simultaneously taking the course Traffic Engineering (101-0437-00 G) is encouraged.

### Major in Hydraulic Engineering and Water Resources Management

#### Selected Topics on Hydraulic Engineering

**Lecturers:** R. Boes, I. Albayrak

**ECTS:** 3 credits

**Prerequisites:** 101-0247-01L Hydraulic Engineering II or equivalent course.

**Course Description:**

- The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.
- To deepen knowledge on special aspects in hydraulic engineering and to understand the procedures and the planning sequence of hydropower projects.

**Additional literature recommendations:**

Additional literature recommendations will be provided at lectures.

**Lecture notes:**

Lecture notes/handouts will be available online.

**Literature:**

External speakers will present current topics and projects in Switzerland and abroad.

### Numerical Modelling in Fluvial Hydraulics and River Engineering

**Lecturers:** D. F. Vetsch, A. Siviglia

**ECTS:** 3 credits

**Prerequisites:** Relevant books and citations will be mentioned.

**Course Description:**

- The basics of numerical modelling of fluvial hydraulics and river engineering problems are presented. The governing equations for flow and sediment transport in open channels and corresponding numerical solution strategies are introduced. The theoretical parts are discussed by examples.
- Get to know possibilities and limitations of numerical modelling in fluvial hydraulics and river engineering.

**Additional literature recommendations:**

Relevant books and citations will be mentioned.

**Lecture notes:**

Slides of lecture are available for download as PDF. Supplementary material will be provided during lecture.

**Literature:**

Exercises are based on the simulation software BASEMENT (www.basement.ethz.ch), the open-source GIS Qgis (www.qgis.org) and code examples written in MATLAB. The applications comprise one- and two-dimensional approaches for the modelling of flow and sediment transport.

**Requirements:**

- MATLAB programming skills would be an advantage.

### Applied Glaciology

**Lecturers:** M. Funk, A. Bauder

**ECTS:** 3 credits

**Prerequisites:**

- To understand the fundamental physical processes in glaciology.
- To learn some basic numerical modelling techniques for glacier flow.
- To identify glaciological hazards and to learn some assessment and mitigation possibilities.

**Course Description:**

- We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

**Additional literature recommendations:**

Additional relevant readings, mostly scientific articles, will be recommended throughout the course.

**Notice:**

There are no pre-requisites for this course. The course Transport Simulation (101-0438-00 G) and previous experience with VISSIM is helpful but not mandatory. In addition, simultaneously taking the course Traffic Engineering (101-0437-00 G) is encouraged.
Basics in physical glaciology
- Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges
- Ice falls, ice avalanches
- Glacier floods
- Lake ice and bearing capacity

Lecture notes
- Handouts are available

Literature
- Relevant literature will be provided during the lecture.

Prerequisites / notice
- For current case studies, risk-based measures for glaciological natural hazards will be discussed.
- Prerequisites: Basic knowledge in mechanics and physics is assumed.

101-1249-00L
Wastewater Hydraulics
- 3 credits
- 2G
- W. H. Hager

Abstract
- The basics of wastewater hydraulics are described from the environmental and the hydraulic points of view, presenting also examples from engineering practice. Typical case studies are further described during a laboratory visit of VAW.

Objective
- Understanding and computation of the essential hydraulic processes in wastewater hydraulics are presented. On the one hand, free-surface hydraulics is reviewed with particular reference to problems in wastewater hydraulics, whereas various special hydraulic structures such as manholes, separation structures and collector channels are analyzed with a hydraulic approach on the other hand. Particularities of wastewater schemes including deposits and the choking of a sewer as the abrupt transition from free-surface to pressurized high-speed flow are highlighted.

Content
- Fundamentals
- Hydraulic losses
- Design of hydraulic elements
- Uniform flow
- Critical flow
- Energy dissipation
- Backwater curves
- Culvert and inverted siphon
- Overflows
- Venturi flume
- Mobile discharge measurement
- Drop and vortex drop
- Bend and junction manhole
- Sidewalk
- Lateral overflow
- Bottom opening
- Side channel

Lecture notes
- Text books

Literature
- Exhaustive references are contained in the 'scripts'.

Prerequisites / notice
- Visit of VAW hydraulic laboratories to add to applied resources. Description of a number of selected, at the time available hydraulic models.

102-0215-00L
Urban Water Management II
- 3 credits
- 2G
- M. Maurer, P. Staufer

Abstract

Objective
- Consolidation of the basic procedures for design and operation of technical networks in water engineering.

Content
- Demand Side Management versus Supply Side Management
- Optimierung von Wasserverteilnetzen
- Druckstösse
- Kalkausfällung, Korrosion von Leitungen
- Hygiene in Verteilsystemen
- Siedlungshydrologie: Niederschlag, Abflussbildung
- Instationäre Strömungen in Kanalisationen
- Stofftransport in der Kanalisation
- Einleitbedingungen bei Regenwetter
- Versickerung von Regenwasser
- Generelle Entwässerungsplanung (GEP)

Lecture notes
- Written material and copies of the overheads will be available.

Prerequisites / notice
- Prerequisite: Introduction to Urban Water Management

Major in Materials and Mechanics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tr>
<td>101-0619-00L</td>
<td>Mechanics of Building Materials</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
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</tbody>
</table>

Abstract
- Material models comprise our knowledge on the physical behavior of materials. Based on a short introduction to solid mechanics, 3D material laws for elastic, visco-elastic behavior, plasticity and damage mechanics are discussed. We focus on material laws for concrete, metals, wood and other composites, how to obtain parameters from mechanical tests and their application in FEM calculations.

Objective
- This introductory course aims to bridge the gap between phenomenological, qualitative comprehension of processes in building materials, their characterization in mechanical testing and the ability to apply those for practical design purposes via constitutive models.

Upon completion of the course you should be able to:
- classify different material behavior (e.g. linear/non-linear elastic, elasto-plastic, creep) with respect to types of constitutive material models (total/incremental strain models, damage / plasticity models, linear visco-elasticity).
- review how incremental strain models (e.g. elasto-plastic) are algorithmically implemented in Finite Element software (UMat of Abaqus),
- formulate the main approach and assumptions to the most import models for building materials and discuss their limitations,
- propose experimental campaigns for obtaining relevant material parameters for non-linear material models.
### Content
- Introduction to constitutive models for materials
- Fundamentals of mechanics of materials
- Cauchy-, hyper- and hypoelastic material descriptions
- Constitutive Models for Concrete (non-linear elastic)
- Introduction to metall and concrete plasticity
- Introduction to ABAQUS UMAT Programming
- Damage continuum mechanics
- Linear visco-elastic materials

### Lecture notes
Will be provided during the lecture.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>101-0639-01L</td>
<td>Science and Engineering of Glass and Natural Stone in Construction</td>
<td>3</td>
<td>W</td>
<td>F. Wittel, T. Wangler</td>
</tr>
<tr>
<td>101-0659-01L</td>
<td>Durability and Maintenance of Reinforced Concrete</td>
<td>3</td>
<td>V</td>
<td>B. Elsener, U. Angst</td>
</tr>
</tbody>
</table>

### Abstract
The course offers an overview of relevant practical issues and present technological challenges for glass and natural stones in constructions. Students gain a good knowledge of the basics of glasses and natural stones, their potential as engineering materials and learn to apply them in the design of civil engineering constructions and to evaluate concepts.

### Objective
Glass is increasingly used in constructions to ease the construction process, as functional insulation barrier, even for structural applications of impressive size. While everyone has experienced the innovation potential of glass in the last decade, products from natural stone suffer from an unjustified traditional image that often originates from a lack of understanding of the material and its combination with other materials. Culturally important structures often are made from natural stone and their conservation demands an understanding of their deterioration mechanisms, the concepts of which can be applied to other civil engineering materials. Designers and engineers need the knowledge to reconcile materials and system behavior with the entire processing, handling, integration and life time in mind. In this module students are provided with a broad fundamental as well as practice-oriented education on glass and natural stone in civil engineering applications. Present and future construction and building concepts demand for such materials with optimized properties.

Based on the fundamentals from the Bachelor course in materials by the end of this module, you should be able to:

- recognize and choose specific applications from the broad overview you were provided with,
- relate processing technologies to typical products and building applications and recognize (and explain typical damage related to wrong material choice or application,
- explain the nature of glassy and crystalline materials and interpret their physical behavior against this background,
- explain the major deterioration mechanisms in natural stone and how this relates to durability,
- analyze material combinations and appraise their application in future products as well as integration in existing constructions,
- summarize with appropriate guidance publications on a related topic in an oral presentation and short report.

### Content
Lecture 1: An introduction to science and engineering of glass and natural stone in construction (FW/TW)
Lecture 2: Glass chemistry including historical development of glass composition, use of raw materials, melts, chemical stability and corrosion. (FW)
Lecture 3: Geology and mineralogy of stones used in construction. Formation processes, chemistry, crystal structure. (TW)
Lecture 4: Microscopic models for glassy materials. Physics of glass transition. From microscopic physical models to thermodynamics, rheology and mechanics of glassy materials. (FW)
Lecture 5: Stone properties and behavior: microstructure, density, porosity, mechanical properties (TW)
Lecture 6: Glass physics: Optical properties (transmission, reflection, emission, refraction, polarization and birefringence, testing methods); Mechanical properties (density, thermal, mechanical, electric properties, glass testing) (FW)
Lecture 7: Stone properties and durability: transport, moisture and thermal cycling (TW)
Lecture 8: Forming and processing of glass: (plate and molded glass, drawing, slumping, profiling etc.; Processing: Cutting, mechanical processing, tempering, gluing, bending, laminating of glass Surface treatments: coating, sputtering, enameling, printing, etching, chemical pre-stressing.) (FW)
Lecture 9: Durability: Salt crystallization, freezing, biodeterioration (TW)
Lecture 10: Glass products for civil engineering applications; (Molded glasses, fiber glass, foam glass, plate glass); construction glass (insulation glass, structural glass, protective glass, intelligent glass, codes); (FW)
Lecture 11: Conservation: Consolidation, cleaning, and other treatments (TW). Practical aspects (guest lecturer)
Lecture 12: Glass in constructions. (modelling, application and regulation, typical damage in glass) (FW)
Lecture 13: Student presentations; exam questions (FW/TW)

### Literature
Werkstoffe II script (download via the IFB homepage). Rest will be handed out in the lectures

### Prerequisites / Notice
Werkstoffe I/II of the bachelor studies or equivalent introductory materials lecture.
Objective
Understand the mechanism of deterioration of RC structures, in particular reinforcement corrosion.
Know the relevant parameters affecting durability of reinforced concrete, in particular cover depth, concrete quality, moisture, and the ways to control durability
Understand the current approaches for design for durability (exposure classes, prescriptive) and be aware of their limitations
Know the future performance-based models for durability design and the difficulties in defining input parameters (such as critical chloride content).
Know and understand different ways to improve durability of RC structures (e.g. stainless steel reinforcement)
Know the particular problems with post-tensioned structures and ways to overcome them (electrically isolated tendons).
Know and understand the non-destructive methods for inspection and condition assessment (especially half-cell potential mapping) and be aware of the limitations
Know and understand repair methods such as conventional repair, electrochemical methods (in particular cathodic protection)
Be aware of differences in performance of the new blended cements (especially CEM II with limestone) respect to the traditional Portland cement and the possible future problems for durability.

Content
Reinforced concrete combines the good compressive strength of concrete with the high tensile strength of steel and has proven to be successful in terms of structural performance and durability. However, there are instances of premature failure of reinforced concrete and prestressed concrete components due to corrosion of the reinforcing steel with very high economic implications of such damage. This course focuses on the chloride and carbonation induced corrosion of steel in concrete, presenting transport mechanisms and electrochemical concepts. The main emphasis lies on design and execution aspects related to durability of new and existing structures.
New methods and materials for preventative measures, condition assessment and repair techniques are discussed. The course is a point of reference for engineers and materials scientists involved in research and practice of corrosion protection, rehabilitation and maintenance of reinforced concrete structures and components.

Content of the course in detail:

Lecture 1
Administrative issues, literature, what do students expect to learn? Introduction (economic relevance of durability, transition from building to maintenance), Fundamentals of corrosion and durability / Passivity and pitting corrosion

Lecture 2
Reinforced concrete / Corrosion protection / Degradation mechanism corrosion (chlorides/carbonation) / electrochemical mechanism / controlling parameters / cracks and spalling on surface, danger of localized corrosion

Lecture 3
Other degradation mechanisms: sulphate attack, ASR, frost attack
Various examples, frequency of occurrence of individual deterioration mechanisms

Lecture 4
Service life: initiation stage & propagation stage. Durability design: prescriptive approach, constructive detailing, importance of moisture for almost all degradation mechanisms. Performance based approach, simple diffusion approach for chloride ingress, Critical chloride content (influencing parameters)

Lecture 5
Stainless steel as reinforcing steel for concrete / different types of stainless steels / mechanical properties / corrosion resistance, passivity / coupling with black reinforcing steel / examples of application / life-cycle-costs

Lecture 6
Inspection and condition assessment I: visual inspection / destructive testing (chloride profiles, carbonation depth, thin section analysis, etc.)

Lectures 7
Inspection and condition assessment II: non-destructive testing (potential mapping, cover depth measurement, resistivity measurement). Potential mapping: measurement principle / effect of carbonated cover zone / effect of moisture / examples

Lecture 8
Post-tensioned structures / problem with existing structures: no NDT method / approach for protection (multiple barrier) / new systems with polymer ducts / electrically isolated tendons / fib guidelines / Swiss guideline / Monitoring techniques / Applications

Lecture 9
Repair methods I: conventional repair / coatings / inhibitors / limitations

Lecture 10
Repair methods II: electrochemical repair methods (ECR, ER, CP) / principles / electrochemical chloride removal (theory and examples) / electrochemical realkalization (theory and examples) / when can these methods be applied? / cost aspects

Lecture 11
Repair methods III: cathodic protection (theory, technical solutions, anode systems, etc and examples). Monitoring of CP

Lecture 12
New cements, issue of CO2 reduction. Effects of fly ash, slag, limestone on workability, diffusion coefficient, resistivity, pH (including a discussion of the pozzolanic reaction and its consequences with respect to pH buffering Portlandite reserve). Discuss products on the Swiss market.

Lecture 13
Summary of most important points of this course given by the students. Open discussion about durability design, use of new cements, new materials and repair methods. Expected consequences for practice? Course evaluation and time for asking questions.

Lecture notes
The course is based on the book
Slides of the lectures will be distributed in advance
Special hand outs and reprints for particular topics will be distributed

Literature

Prerequisites / notice
Students are encouraged to actively participate during the lectures. Students are expected to work on all the exercises (four). For one exercise a detailed written solution of the exercise has to be delivered (after the discussion).

Students should have passed the exams on Werkstoffe I and II.

### 101-0689-00L Bituminous Materials

**Abstract**

Introduction into special aspects of the mechanical and chemo-physical properties as well as the structure and application of bituminous materials for road and waterproofing application considering also new R&D trends

**Objective**

Introduction into special aspects of the mechanical and chemo-physical properties as well as the structure and application of bituminous materials for road and waterproofing application considering also new R&D trends.

**Content**

- Basics of mechanical behavior: Viscosity, rheological models, viscoelasticity, time-temperature superposition, fatigue, viscoplasticity.
- Bituminous binders: Tar-related issues, bitumen, natural asphalt, polymer modified bitumen, technological tests, mechanical-physical properties, binder classification, bitumen emulsions, foam bitumen.
- Asphalt pavements: material structure and concepts, production, mixture testing and characterization, mixture types, recycling.
- Waterproofing membranes: tack-coats, structure of polymer modified waterproofing membranes, production, typical tests, system-related properties, construction and application.

**Lecture notes**

Script, handed out during lecture

**Prerequisites / notice**

The lecture comprises two written exercises and one literature exercise with short presentation that are requested to be done.

### 101-0689-00L Shrinkage and Cracking of Concrete: Mechanisms and Impact on Durability

**Abstract**

Concrete is generally viewed as a durable construction material. However, the long-term performance of a concrete structure can be greatly compromised by early-age cracking. This course will explain how shrinkage of concrete leads to cracking and how control of shrinkage allows increasing the expected durability of a concrete structure.

**Objective**

This course will begin with a brief introduction about hydration and microstructure development in cement paste and concrete. The students will learn the main causes of cracking at early ages, namely plastic, drying, thermal and autogenous shrinkage, with special emphasis on the driving mechanisms. The importance of concrete curing, especially in the first few days after casting, will be explained. Building on the knowledge of the driving forces of shrinkage, the way of action of shrinkage-reducing admixtures will be clarified and different applications illustrated. As an extension of external curing, the students will become familiar with internal water curing by means of saturated lightweight aggregate and superabsorbent polymer.

Most concrete members are restrained by adjacent structures. When shrinkage is restrained, cracks may develop. The students will learn how to apply different criteria for assessing concrete cracking and how to retrieve the mechanical properties of the concrete, especially stiffness and creep, relevant for the calculations.

In addition to macroscopic cracks, microcracking may occur in the cement paste due to inner restraint offered by the aggregates. Both macroscopic cracks and diffuse microcracking within a concrete may facilitate the ingress of harmful substances (e.g. chloride and sulfate ions) into the concrete; these may react with the concrete or with the reinforcement and create further deterioration. The students will acquire an understanding of the mechanisms of transport through cracked concrete, with special focus on experimental evidence and on techniques able to visualize the transport process and follow it in time.

As a final outcome of the course, the students will be able to estimate the impact of cracking on the expected durability of concrete structures and to implement different types of measures to reduce the extent of cracking.

**Content**

- Concrete is generally viewed as a durable construction material. However, the durability of a concrete structure can be jeopardized by shrinkage-induced cracking. In addition to being unsightly, cracks have the potential to act as weak planes for further distress or as conduits for accelerated ingress of aggressive agents that may reduce durability.

- Advances in concrete technology over the past decades have led to the practical use of concrete with a low water to binder ratio and with different types of mineral and organic admixtures. Another recent development is self-compacting concrete, which avoids concrete vibration and reduces labor during placing. Unfortunately, these concretes are especially prone to cracking at an early age, unless special precautions are taken. Proper curing becomes in this case the key to achieve better performance in various environmental and load conditions.

- Specific topics covered by the course:
  - Hydration and microstructure development
  - Plastic shrinkage
  - Development of mechanical properties
  - Thermal deformation
  - Autogenous deformation
  - Drying shrinkage
  - Curing
  - Shrinkage-reducing admixtures
  - Internal curing: saturated lightweight aggregate and superabsorbent polymer
  - Fracture and microcracking
  - Transport in cracked concrete
  - Impact of cracking on concrete durability

**Lecture notes**

For each lecture, lecture notes will be provided. In addition, one or two research papers for each lecture will be indicated as supportive information.

**Literature**

Copies of one to two research papers relevant to the topic of each lecture will be provided to the students as supportive information.

A basic knowledge of concrete technology is preferable.

### 151-0353-00L Mechanics of Composite Materials

**Abstract**

The course Mechanics of Composite Materials is dedicated to modeling problems following from the complex mechanical behavior of these anisotropic material structures. and modeling of continuous fibre reinforced composites. Participants will be able to design parts for the mechanical, automotive and aerospace industry.

**Objective**

Understanding of the mechanical properties of fiber reinforced composites with regard to analysis and design of lightweight structures for mechanical, transportation and aerospace applications.

**Content**

1. Introduction and Elastic Anisotropy
2. Laminate Theory
3. Thick-Walled Laminates and Interlaminar Stresses
4. Edge Effects at Multidirectional Laminates
5. Micromechanics
6. Failure Hypotheses and Damage Prediction
7. Fatigue Response
8. Joining and Bonding Techniques
9. Sandwich Designs

**Literature**

- Manuscript and handouts in printed form and as PDF-files:
  - http://www.structures.ethz.ch/education/master/intro/compulsory/mechanics

**Lecture notes**

The lecture material is covered by the script and further literature is referenced in there.

### 151-0833-00L Principles of Nonlinear Finite-Element-Methods

**Abstract**

The course Principles of Nonlinear Finite-Element-Methods is designed to give a fundamental understanding of nonlinear finite-element methods. The course is suitable for mechanical, civil, and aerospace engineers, as well as for physicists and engineers in other fields who need to model nonlinear behavior.

**Objective**

- The objective of the course is to provide students with a comprehensive understanding of the principles of nonlinear finite-element methods.
- Students will learn how to apply these methods to solve complex engineering problems.
- The course will cover topics such as nonlinear elasticity, plasticity, and fracture mechanics.

**Content**

- Nonlinear elasticity
- Plasticity
- Fracture mechanics
- Continuum mechanics
- Finite-element methods
- Nonlinear solid mechanics

**Literature**

- The lecture material is covered by the script and further literature is referenced in there.

**Prerequisites / notice**

A basic knowledge of finite-element methods is preferable.
Abstract
Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

Objective
The goal of the lecture is to provide the students with the fundamentals of the nonlinear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:
- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations

Content
- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Lecture notes
yes

Literature

Prerequisites / notice
If we will have a large number of students, two dates for the exercises will be offered.

101-0637-10L Structures of Wood and Function

- Remark: Replaces 701-1801-00L
- Thus, Students having already assigned to 701-1801-00 are not allowed to assign to 101-0637-10.

Abstract
The lecture Wood structure and function conveys basic knowledge on the microstructure of softwoods and hardwoods as well as general and species-specific relationships between growth processes, wood properties and wood function in the living tree.

Objective
Learning target is a basic understanding of the anatomy of wood and the related impact of endogenous and exogenous factors. The students can learn how to distinguish common central European wood species at the macroscopic and microscopic level. A deeper insight will be given by wood identification exercises for softwood species. Further the students will gain insight into the relationships between tree growth and wood properties with a specific focus on the wood function in the living tree.

Content
In an introduction to wood anatomy, the general structural features of softwoods and hardwoods will be explained and factors of diversity and variability will be discussed. A specific focus is laid on common central European tree species with relevance in the wood sector, which will be studied in macro- and microstructural investigations. For softwoods, exercises for the identification of species will be conducted. In the following, relationships between wood structure, properties and function in the living tree will be in the focus of the lecture. Topics covered are mechanical stability and water transport, branches, reaction wood formation (compression wood, tension wood), spiral growth, growth stresses as well as adaptive growth of trees.

101-0637-20L Fundamentals of Wood Elaboration and Woodmachining

- Remark: Replaces 701-1803-00. Thus, students having already assigned to 701-1803-00 are not allowed to assign to 101-0637-20.

Abstract
The lecture Wood processing conveys knowledge on technological properties of wood and wood-based materials as well as on industrial processes for the fabrication of a vast variety of wood products.

Objective
Learning target is a fundamental understanding of the dominating wood machining processes, which are applied to fabricate common wood products. Students will be introduced to the economic relevance of the renewable resource wood and are trained in its technological properties. The students will learn to identify the relationships between wood species and their properties as well as the suitable wood machining processes to fabricate targeted wood products.

Content
The general introduction shows the economic relevance of the resource wood in a global, European and Swiss context and reflects aspects of sustainability in wood production and certification. In terms of bulk wood products a specific focus is laid on sawn timber production and drying processes. With regard to wood veneer production, steaming, veneer cutting and assembly to veneer lumber products are presented. Further the common technologies for the production of particle boards and fibre boards as well as potential and limitations in the application of wood and wood-based products. At the end of the lecture an excursion to a Swiss wood manufacturer is planned, in order to facilitate practical experience.

151-0735-00L Dynamic Behavior of Materials and Structures

Abstract
Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

Objective
Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

Content
Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Lecture notes
Slides of the lectures, relevant journal papers and users manuals will be provided.

Literature
Various books will be recommended covering the topics discussed in class

Prerequisites / notice
Course in continuum mechanics (mandatory), finite element method (recommended)

Projects

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<tr>
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<td><strong>Costruire correttamente/Constructing Correctly:</strong> Curved Bearing and Folded Bearing Structures</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>G. Birindelli</td>
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<tr>
<td>051-0821-15L</td>
<td><strong>Summer School: Markets in the Tropics - Barranquilla</strong></td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>H. Klumppner, A. Brillembourg, M. Stauffacher</td>
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</tbody>
</table>

**Abstract**

- Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.
- The project work is supervised by a professor. Students can choose from different subjects and tasks.
- The project work requires normally 250 to 300 hours of work.

**Objective**

- Working on a concrete task in Construction Engineering
- Working on a concrete task in Hydraulic Engineering
- Working on a concrete task in Geotechnical Engineering
- Working on a concrete task in Transport Systems
- Working on a concrete task in Materials and Mechanics
- Working on a concrete task in Construction and Maintenance Management

**Content**

- The project work is supervised by a professor. Students can choose from different subjects and tasks.

**Electives**

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

**Electives ETH Zurich**

**Recommended Electives of Master Programme**

This summer school will function as an inter-disciplinary think-tank, exploring the requisites for sustainable urban development in Barranquilla through the lens of architecture, engineering, and environmental sciences. You will be challenged to work in an intensive cross-cultural setting and develop solutions in a complex, real-life context with local practitioners and stakeholders.

**Course Catalogue of ETH Zurich**

Data: 06.12.2018 13:04  Autumn Semester 2015  Page 144 of 1432
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed. You will receive full support on-site from Universidad del Norte and ETH tutors from your discipline. In developing the scenarios you will work side by side with young professionals with a grounded knowledge of the field, and be joined by a wide variety of local stakeholders. The program will combine site visits, expert lectures and workshops to allow you to develop the following skills:

- The capacity to work to address urban challenges in an inter-disciplinary team
- Apply Scenario Analysis technique to structure and integrate knowledge from various fields
- Cross cultural understanding and skills in an international collaboration
- Mechanisms to collaborate and communicate with practitioners and stakeholders
- Understanding of integrated and sustainable urban development
- Ability to use stakeholder participation to solve real world problems
- Mid-sized cities in Latin America are growing at unprecedented rates. The next decade will be decisive in terms of demographic and economic growth, creating a time window to respond to unprecedented demands on resources, such as land, water and energy.

Are these boomtowns doomed to follow the fate of megacities or will they successfully avoid the pitfalls of rapid urban development? This program is part of a three-year ambitious collaboration with the Inter American Development Bank’s Emerging and Sustainable Cities Initiative and the Swiss Ministry for Economic Cooperation (SECO). It will influence decision makers and engage with real issues.

ETH is teaming up with the leading Universidad del Norte in Colombia to focus on Barranquilla, a rapidly growing city of 1.2 million inhabitants on the Atlantic coast of Colombia. Following a period of decline, vast sums of foreign investment are now flowing into this port city, with the potential to reverse current inequalities and spark more sustainable development.

In a team, you will produce alternative urban scenarios for the redevelopment of Barranquillas Central Market. You will contribute your expertise and unpack the realities of sustainable development in a tropical climate. How can knowledge from the ETH be combined with leading Colombian research and translated to a Latin American context? Through debate, controversy and collaboration it is expected you produce scenarios that integrate your different disciplines and question the preconceptions of sustainable urban development.

This immersive summer school will be structured in three interlocking modules:

1. In the first module you will investigate the central market and gain a strong understanding of the social, environmental and built context in Barranquilla. You will employ and combine your varied disciplinary methodologies to gain insight into the sustainability challenges facing the city and the redevelopment of the avenue.

2. In the second module, you will develop a series of scenarios for the central market in Barranquilla, proposing alternatives for its sustainable future. You will build on research from the first module, and explore the potential of your ideas with local stakeholders and professionals from your field. You will document these scenarios using creative and varied representational methods.

3. In the final module you will pitch your scenarios to decision makers. During this high-level event you will measure their preferences, debate the associated trade-offs, and provide a series of orientations for those planning the future of Barranquilla.

Enthusiastic students currently enrolled in a masters program in ETH Zurich and Universidad del Norte, Barranquilla Colombia. A balanced group of 12 ETH master students from the D-ARCH, D-USYS and D-BAUG departments will be selected. They will be joined by 12 Colombian students from our partner university in Barranquilla, Universidad del Norte.

Applicants should have a strong interest in sustainable urban development and trans disciplinary collaborative research. They should be able to demonstrate their academic strength, motivation, interest and expertise. Knowledge of Spanish is welcomed but not obligatory.

ETH participants will be charged a fee of 300 CHF to cover local activities, travel and accommodation.

Students will be responsible for organising visa, health insurance, and transportation to and from Barranquilla. Flights to Barranquilla from Zurich cost approximately 1700 CHF. Additional travel grants are available for ETH students.

Applications can be submitted including curriculum vitae, portfolio where relevant and letter of motivation as portable document format (pdf) by May 30th, 17:00 CET to hertzog@usys.ethz.ch

Notification for admission June 1st.

### Compulsory Electives in Humanities, Social and Political Sciences

- **Recommended GESS compulsory elective courses (Type B) for D-BAUG.**
  - see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
  - see GESS Compulsory Electives: Language Courses ETH/USY

### Master Thesis

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<tr>
<td>101-0010-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>24</td>
<td>47D</td>
<td>Supervisors</td>
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</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;

b. fulfilling of any additional requirements necessary to gain admission to the master programme.

The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

To work independently and to produce a scientifically structured work.
Content

The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

<table>
<thead>
<tr>
<th>Civil Engineering Master - Key for Type</th>
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<tbody>
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ECTS: European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Compulsory Subjects

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<tr>
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<td>E. de Bruijn</td>
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</tbody>
</table>

**Abstract**
The master thesis accompaniment seminar with ethical discussions, obtaining research plans, literature searches, critical discussion of original publications, and obtaining possible solutions when confronted with experimental problems.

**Objective**
The seminar helps during the master thesis in order to enable a successful completion of the thesis.

**Prerequisites / notice**
Findet nach Vereinbarung statt.

### Electives

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<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

**Objective**
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

**Content**
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Lecture notes**
Lecture notes and handouts

**Literature**

**Prerequisites / notice**
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Várös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

**Objective**
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

**Content**

**Lecture notes**
Practical and theoretical exercises in small groups in the laboratory.

**Lecture notes**
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

**Lecture notes**
AND

**Literature**
https://www1.ethz.ch/lbb/Education/BME

<table>
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<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>227-1051-00L</td>
<td>Introduction to Systems Neuroscience</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>D. Kiper</td>
</tr>
</tbody>
</table>

**Abstract**
This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions.

**Objective**
To understand the basic concepts underlying perceptual, motor and cognitive functions.

**Content**
Main emphasis sensory systems, with complements on motor and cognitive functions.

**Lecture notes**
None

**Literature**
"Principles of Neural Science", Kandel, Schwartz, and Jessel

**Prerequisites / notice**
none

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Grote</td>
</tr>
</tbody>
</table>

**Abstract**
Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.
This course introduces/explores the complex relationship between physical activity, sedentary behavior and health. It will discuss:

- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
-Balancing stability and flexibility in organizations as design criterion
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

A list of required readings will be provided at the beginning of the course.

The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students.

**Objective**
- Know effects of work design on competence, motivation, and well-being
- Understand links between design of individual jobs and work processes
- Know basic processes involved in systematic organizational change
- Understand the interaction between organization and technology and its impact on organizational change
- Understand relevance of work design for company performance and strategy
- Know and apply methods for analyzing and designing work

**Content**
- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterion
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

**Literature**

A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

**Prerequisites / notice**

The course is designed for students with a background in health sciences or related fields. Prior knowledge of applied statistics is required. Self-study material will be available at the beginning of the course and statistical knowledge will be tested through practical exercises to solve problems relevant to the neural control of behavior.

**Number of participants limited to 20.**

**Objective**

The goal of this course is to nurture and develop independent thinking which is a vital component of personal and professional development. The course will introduce students to academic papers, present logical arguments, source reliable information and design thought experiments to solve problems relevant to the neural control of behavior.

**Prerequisites / notice**

Students are required to have successfully completed the course "Neural control of movement and motor learning" and to have basic knowledge of applied statistics. Self-study material will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week (open book). Passing this test is a requirement for continuing the course. Students will be required to write essays, give presentations and participate in discussions on a regular basis. Assessment will be made on the basis of the complete aforementioned practical work.

**Objective**

On completion of this course students will be able to demonstrate:

1. knowledge of and critical awareness of the role of physical activity and sedentary behavior in the maintenance of health and the etiology, prevention and treatment of disease.
2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases
3. awareness of current national and international physical activity policies and how these impact on global challenges

**Content**

Introduction to Physical Activity for Health, including sedentary behavior
Physical activity epidemiology; concepts principles and approaches
Physical activity and all cause morbidity and mortality
Physical activity and chronic disease; Coronary heart disease, diabetes, bone health, cancer and obesity
Physical activity and brain health
Physical activity and sedentary behavior recommendations
Population prevalence of physical activity and sedentary behavior
Physical activity policies
Physical activity assessment

**Literature**

Core texts for this course are:

Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity

**Prerequisites / notice**

From the BSc-course the following book is recommended: ‘Essentials of strength training and conditioning’ T. Baechle, R. Earle (3rd Edition)

**Objective**

Understanding for the development and adaptation of sports from the ancient world to present times.

**Content**


**Lecture notes**

Ein Skript für die aktuelle Veranstaltung wird abgegeben.

**Literature**

Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik
- Bedeutung des Sports im Kindes- und Jugendalter
- Leistungssport im Kindes- und Jugendalter
- Pädagogische Perspektiven des Sportunterrichts in der Schule
- Ein zeitgemässer Schulsport
- Bewegungskulturelle Bildung: Bewegungszerziehung, Spielerziehung

Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

**376-1111-00L Health and Posture I**

**Abstract**
Analysis of posture: Development of the functionally correct posture

**Objective**
To provide a comprehensive understanding of posture and its development within sports and physical activity.

**Content**
- Observation of body sections: statics, norm, constitution
  - Perception of the own posture
  - Analysis of the own posture
  - Status of the posture standing
  - Neutral liability on the
  - Back injuries - healthy back
  - Tension / Stability
  - Tone regulation
  - Sensomotor activity (treats the capacity to feel the own movements, transfer from theory into practice of programming and modifying neuromotoric movements)

**376-1117-00L Sport Psychology**

**Abstract**
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

**Objective**
- Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology.

**Content**
- Main Topics
  - Introduction to sport psychology
  - Cognitions in sports; mental rehearsal and mental training
  - Emotions and stress
  - Motivation: goal-setting in sports
  - Career and career transition in elite sport
  - Coach-Athlete-Interaction
  - Psychological aspects of sport-injury rehabilitation
  - Group dynamics in sport

**Literature**

**376-1127-00L Sociology of Sport**

**Abstract**
These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

**Objective**
- The lectures set out to:
  - present the different dimensions, functions and interrelationships of present-day sport
  - provide an introduction to the central theories and models of (sport) sociology
  - show how far sport reflects society and how it changes and becomes more differentiated in the process
  - take current examples from newspapers, magazines and television to highlight the sociological view of sport.

**Content**
- Social and sport change: developments and trends
- The economy and the media: dependencies, consequences, scandals
- Social inequalities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

**Literature**

A detailed program with additional references will be delivered at the beginning of the lecture.

**376-1155-00L The Musculoskeletal System and Work**

**Abstract**
Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.
Objective
Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal system during work. Prevention and rehabilitation of work related musculoskeletal disease will be discussed with the help of a bio-psycho-social model. Furthermore, evidence based methods for a healthy work design will be presented.

Content
Insights of human movement sciences concerning wear, overtraining and regeneration of the musculoskeletal system form an important base for an ergononic work design. The following topics will be covered: Muscle fatigue in an 8-hours-day, mouse appliance, back pain, insertion tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, and measurement methods.

Lecture notes
Skript und Folien auf NETZ als PDF-Datei zur Verfügung

Prerequisites / notice

376-1305-00L Development of the Nervous System 3 credits 2V E. Stoeckli, further lecturers

Abstract
The course covers the development of the nervous system (NS) with a focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Content
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Lecture notes
EHT students: Lecture notes will be provided on Moodle https://moodle.app2.let.ethz.ch/course/view.php?id=694

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice
None. Bring something to write and your student ID

376-1305-01L Structure, Plasticity and Repair of the Nervous System 3 credits 2V M. E. Schwab, L. Filli, K. A. Martin, further lecturers

Abstract
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

Prerequisites / notice
Repetitionsprüfung 15. Juni 2016, HG E 26.1, 9-10.30h

376-1665-00L Training and Coaching I 3 credits 2G O. Buholzer

Abstract
The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development

Objective
- To develop basics for a differentiate analyses of sports (model)
- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion

Content
Das Modell der Sportartenanalyse
Die Relevanz der einzelnen Leistungsfaktoren
Das Modell der Wettkampfanalyse
Folgerungen für das Training und Coaching in der Sportart
Folgerungen für das Nachwuchsstraining
Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
Das Nachwuchs- und Talenttraining (Sichtung, Selektion, Förderung)
Projekte aus der Praxis (Talent- und Nachwuchsstraining)
Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
Praxistheorie und -praxis

Lecture notes
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

Literature
Struktur sportlicher Leistung (Modellsatz von Gundlach; (Trainingswissenschaften S. 45 - 49; Stiehler(Konzag/Döbler)

Leistungsdiagnostische Verfahren, Stiehler(Konzag/Döbler)

Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006


Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002

Das neue Konditionstraining, Grosser/Statischka/Zimmermann, blv 2002

Kredit/Prüfung
Für die Kreditvergabe sind die vorgeschriebenen Semesterarbeiten und die Präsenz zwingend. Die Benotung erfolgt durch eine schriftliche Arbeit.

Planung
Die Planungsunterlagen werden zu Semesterbeginn abgegeben, sind provisorisch und können vom Dozenten geändert werden. Die Praxistheorien werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.

Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.


Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important factors for optimizing people's satisfaction & overall performance.

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature
This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals, and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism.

Bioavailability, metabolism and excretion with some focus on energy metabolism.

Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

Handouts can be downloaded.

A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

Nutrition and Chronic Disease (HS) W 3 credits 2V M. B. Zimmermann

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

There is no script. Powerpoint presentations will be made available on-line to students.

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Epidemiology and Prevention W 3 credits 2V M. Eichholzer
The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus preparing them for their future professional life. The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) will be assigned 6 months before the start of the module. The module "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership. The 1-hour written exam will take place during the last lecture in the semester.

### Practical Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-1012-00L</td>
<td>Practical Training II</td>
<td>O</td>
<td>15 credits</td>
<td>15P</td>
<td>E. de Bruin</td>
</tr>
<tr>
<td>Abstract</td>
<td>3-months practical work with topics from the major exercise in movement and training doctrines.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise in movement and training doctrines.</td>
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</tbody>
</table>

### Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-1100-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>30D</td>
<td>E. de Bruin</td>
</tr>
<tr>
<td>Abstract</td>
<td>6-months research study with topics from the major exercise in movement and training doctrines.</td>
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</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- successful completion of the bachelor programme;
- fulfilling of any additional requirements necessary to gain admission to the master programme.
**Major in Biomechanics**

**Compulsory Subjects**

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>376-1651-00L</td>
<td>Clinical and Movement Biomechanics</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>S. Lorenzetti, R. List, N. Singh</td>
</tr>
</tbody>
</table>

*Abstract*
Measurement and modeling of the human movement during daily activities and in a clinical environment.

*Objective*
The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

*Content*
This course includes ethical considerations, measurement techniques, clinical testing, accessing movement data and anlysis as well as modeling with regards to human movement.

**Electives**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0501-00L</td>
<td>Kinematics and Statics</td>
<td>W</td>
<td>5</td>
<td>3V+2U</td>
<td>E. Mazza</td>
</tr>
</tbody>
</table>

*Abstract*
Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power
Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction

*Objective*
The understanding of the fundamentals of statics for engineers and their application in simple settings.

*Content*
Grounding: Lage eines materiellen Punktes; Geschwindigkeit; Kinematik starrer Körper; Translation, Rotation, Kreiselung, ebene Bewegung; Kräfte, Reaktionsprinzip, innere und äussere Kräfte, verteilte Flächen- und Raumkräfte; Leistung
Statik. Äquivalenz und Reduktion von Kräftegruppen; Ruhe und Gleichgewicht, Hauptsatz der Statik; Lagerbewertungen und Lagerkräfte, Lager bei Balkenträgern und Wellen, Vorgehen zur Ermittlung der Lagerkräfte; Parallele Kräfte und Schwerpunkt; Statik der Systeme, Behandlung mit Hauptsatz, mit Prinzip der virtuellen Lasten, statisch unbestimmte Systeme; Statisch bestimmte Fachwerke, ideale Fachwerke, Pendelstützen, Knotengleichgewicht, räumliche Fachwerke; Reibung, Haftreibung, Gleitreibung, Gelenk und Lagerreibung, Rollreibung; Selbstatik; Beanspruchung in Stab trägern, Querkraft, Normalkraft, Biege- und Torsionsmoment

*Lecture notes / notice*
Übungsbücher

*Prerequisites / notice*
Sayir: M.B., Dual J., Kaufmann S., Ingenieursmechanik 1: Grundlagen und Statik, Teubner

*Content*
Written session examination in "Kinematics and Statics" and "Mechanics of Materials" for D-MAVT Students: Students in Human Movement Sciences and Sport and all other Students, who take "Kinematics and Statics" and "Mechanics of Materials":

- Part 1: 20 minutes: Neither notes nor calculators allowed right afterwards:


| 151-0503-00L | Dynamics                                    | W    | 6    | 4V+2U | G. Haller                  |

*Abstract*
Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies
Vibrations

*Objective*
This course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibria and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications.

*Content*

*Lecture notes / notice*
Hand-written slides will be downloadable after each lecture.

*Prerequisites / notice*
Please log in to moodle (https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php), search for "Dynamics", and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.

| 227-0385-10L | Biomedical Imaging                           | W    | 6    | 5G    | S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin |

*Abstract*
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

*Objective*
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Types</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
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<td>4</td>
<td>J. Vöröš, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6</td>
<td>G. Székely, O. Göksel, L. Van Gool</td>
</tr>
<tr>
<td>227-1051-00L</td>
<td>Introduction to Systems Neuroscience</td>
<td>W</td>
<td>6</td>
<td>D. Kiper</td>
</tr>
<tr>
<td>363-0790-00L</td>
<td>Technology Entrepreneurship</td>
<td>W</td>
<td>2</td>
<td>U. Claesson, P. Baschera, F. Hacklin</td>
</tr>
<tr>
<td>376-1219-00L</td>
<td>Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions</td>
<td>W</td>
<td>3</td>
<td>R. Rienner, R. Gassert, L. Marchal Crespo</td>
</tr>
</tbody>
</table>

**Content**
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Prerequisites / notice**
- Introduction into biomechanics as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

**Objective**
- Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

**Content**

**Lecture notes**
- Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

**Literature**
- Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011
Abstract

Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective

Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

Content

Introduction, problem definition, overview
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
  - Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
  - Rehabilitation and use of kinesthetic and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
  - Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
  - Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
  - Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature

Introductory Books:

Selected Journal Articles and Web Links:
- VideoTac, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html
handouts can be accessed online.

### Literature


(available online via ETH library)

**Schmitt K-U, Niederer P, M. Muser, Walz F: "Trauma Biomechanics - Accidental Injury in traffic and sports"**, Springer Verlag

**Schmitt K-U, Niederer P, M. Muser, Walz F: "Trauma Biomechanics - An Introduction to Injury Biomechanics"**, Springer Verlag


**Applied Analysis of Variance and Experimental Design**, L. Meier


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**Prerequisites / notice**

Target Group: Students of higher semesters and PhD students of - Biomedical Engineering, Robotics, Systems and Control - Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome

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**376-1714-00L**

**Biocompatible Materials**

**Abstract**

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

**Objective**

The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

**Content**

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Lecture notes**

Handouts can be accessed online.

**Literature**


(available online via ETH library)

**376-1974-00L**

**Colloquium in Biomechanics**

**Abstract**

Current topics in biomechanics presented by speakers from academia and industry.

**Objective**

Getting insight into actual areas and problems of biomechanics.

**376-1985-00L**

**Trauma Biomechanics**

**Abstract**

Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

**Objective**

This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

**Lecture notes**

Available via homepage.

**Literature**


**376-2017-00L**

**Biomechanics of Sports Injuries and Rehabilitation**

**Abstract**

This lecture introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries.

**Objective**

Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

**Content**

This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

**Lecture notes**

Handouts can be downloaded.

**Literature**


**Prerequisites / notice**

A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

**401-0625-01L**

**Applied Analysis of Variance and Experimental Design**

**Abstract**

Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

**Objective**

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

**Content**


**Lecture notes**

see website

**Literature**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Abstract

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Practical Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3007-00L</td>
<td>Seminar I ▲</td>
<td>O</td>
<td>3 credits</td>
<td>2S</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>Abstract</td>
<td>The master thesis accompanying seminar including discussion of legal and ethical issues, as well as scientific integrity, most important study designs and related statistics. Writing and presenting a research plan, performing literature searches, critical discussion of original publications, and discussion of possible solutions when confronted with experimental problems.</td>
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<tr>
<td>Objective</td>
<td>The seminar prepares for the successful completion of a master thesis through critical review of legal, ethical, technical and scientific aspects.</td>
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<tr>
<td>Content</td>
<td>Ethical and legal issues will be discussed including scientific integrity. An individual ethics application will be written and the personal research plan for the master thesis will be worked out and presented to the group within 30 min. The group critically discusses formal issues and scientific content of the presentation. The literature searches will be optimised and at least one original publication will be orally presented and critically commented. During the master thesis, progress reports will be presented. Should experimental problems occur, the group will discuss possible solutions. When the data of the thesis is analysed, results will be presented (max. 30min). The group will again critically discuss formal and scientific aspects.</td>
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<tr>
<td>Literature</td>
<td>-</td>
<td></td>
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<tr>
<td>Prequisites / notice</td>
<td>Unterlagen werden auf moodle zur Verfügung gestellt.</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3008-00L</td>
<td>Seminar II ▲</td>
<td>O</td>
<td>3 credits</td>
<td>2S</td>
<td>C. Spengler, J. M. Kroepfl</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: successful participation in Seminar I (557-3007-00L).</td>
<td></td>
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</tr>
</tbody>
</table>
Abstract
The master thesis accompanying seminar. Participants present new scientific publications and landmark-papers in form of a short oral presentation and a poster. Furthermore, results of the Master Thesis are presented in a 30-min oral presentation. Critical discussion of scientific and conceptual aspects are trained intensively.

Objective
Critical analysis and discussion, as well as presentation of scientific literature and own results.

Content
Participants present new scientific publications and landmark-papers in form of a short oral presentation and in form of a poster. Furthermore, results of the Master Thesis are presented in a 30-min oral presentation. Thus, the most common types of scientific presentations as well as critical discussion of scientific and conceptual aspects are trained intensively.

Literature
Unterlagen werden in moodle zur Verfügung gestellt.

Prerequisites / notice
Successful completion of Seminar I is required before the start of Seminar II.

Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-00L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>5G</td>
<td>S. Kozelke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Vörös, S. J. Ferguson, S. Kozelke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
<tr>
<td>227-1051-00L</td>
<td>Introduction to Systems Neuroscience</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>D. Kiper</td>
</tr>
<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Grote</td>
</tr>
</tbody>
</table>

Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb, A., Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

Prerequisites / notice

Data: 06.12.2018 13:04 Autumn Semester 2015 Page 159 of 1432
On completion of this course students will be able to demonstrate:

- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterion
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

A list of required readings will be provided at the beginning of the course.

### 363-0790-00L Technology Entrepreneurship

**Objective**

This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

**Content**

See course website

**Lecture notes**

Lecture slides and case material

### 376-0130-00L Laboratory Course in Exercise Physiology

**Objective**

Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today's Sports Medicine.

**Content**

Laboratory course:

Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

**Lecture notes**

Tutorial on Laboratory Experiments in Exercise Physiology

(Editor: Exercise Physiology Lab)

**Literature**

Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg

Kenney/Wilmore/Costill: Physiology of Sport and Exercise, Human Kinetics

**Prerequisites / notice**

Anatomy and physiology classes and lab course in physiology successfully completed (BWS students please contact C. M. Spengler)

Desirable: Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)

### 376-0221-00L Contemporary Problems of Neural Control of Movement

**Objective**

The goal of this course is to nurture and develop independent thinking which is a vital component of personal and professional development. Students will critically evaluate academic papers, present logical arguments, source reliable information and design thought experiments to solve problems relevant to the neural control of behavior.

**Prerequisites / notice**

Number of participants limited to 20.

### 376-0225-00L Physical Activities and Health

**Objective**

On completion of this course students will be able to demonstrate:

1. knowledge of and critical awareness of the role of physical activity and sedentary behavior in the maintenance of health and the aetiology, prevention and treatment of disease.
2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases
3. awareness of current national and international physical activity policies and how these impact on global challenges

**Content**

Introduction to Physical Activity for Health, including sedentary behavior

Physical activity epidemiology; concepts principles and approaches

Physical activity and all cause morbidity and mortality

Physical activity and chronic disease; Coronary heart disease, diabetes, bone health, cancer and obesity

Physical activity and brain health

Physical activity and sedentary behavior recommendations

Population prevalence of physical activity and sedentary behavior

Physical activity policies

Physical activity assessment
The Musculoskeletal System and Work

Core texts for this course are:

Selectie journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity

Objective
From the BSc-course the following book is recommended: ‘Essentials of strength training and conditioning’ T. Baechle, R. Earle (3rd Edition)

<table>
<thead>
<tr>
<th>376-1033-00L</th>
<th>History of Sports</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Gisler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Understanding for the development and adaptation of sports from the ancient world to present times.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Ein Skript für die aktuelle Veranstaltung wird abgegeben.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>376-1107-00L</th>
<th>Sport Pedagogy</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>D. Seiler Hubler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.</td>
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<tr>
<td>Objective</td>
<td>To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.</td>
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</tbody>
</table>
| Content      | Inhaltliche Schwerpunkte der Vorlesung sind:  
- Einführung in die Sportpädagogik  
- Bedeutung des Sports im Kindes- und Jugendalter  
- Leistungssport im Kindes- und Jugendalter  
- Pädagogische Perspektiven des Sportunterrichts in der Schule  
- Ein zeitgemässer Schulsport  
- Bewegungskulturelle Bildung: Bewegungserziehung, Spielerziehung |
| Lecture notes| Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt. |

<table>
<thead>
<tr>
<th>376-1117-00L</th>
<th>Sport Psychology</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>H. Gubelmann</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.</td>
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<tr>
<td>Objective</td>
<td>Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.</td>
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</tr>
</tbody>
</table>
| Content      | Main Topics  
- Introduction to sport psychology  
- Cognitions in sports: mental rehearsal and mental training  
- Emotions and stress  
- Motivation: goal-setting in sports  
- Career and career transition in elite sport  
- Coach-Athlete-Interaction  
- Psychological aspects of sport-injury rehabilitation  
- Group dynamics in sport |
| Lecture notes| Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt. |

<table>
<thead>
<tr>
<th>376-1127-00L</th>
<th>Sociology of Sport</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Lamprech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.</td>
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</tbody>
</table>
| Objective    | The lectures set out to:  
- present the different dimensions, functions and interrelationships of present-day sport  
- provide an introduction to the central theories and models of (sport) sociology  
- show how far sport reflects society and how it changes and becomes more differentiated in the process  
- take current examples from newspapers, magazines and television to highlight the sociological view of sport. |
| Content      | Sport and social change: developments and trends  
- The economy and the media: dependencies, consequences, scandals  
- Social inequalities and distinctions: gender differences and group behavior  
- Conflicts and politics: sports organizations, doping, violence |
| Lecture notes| Selected materials for the lecture are available under www.LSSSBF.ch --> Lehre |

A detailed program with additional references will be delivered at the beginning of the lecture.

<table>
<thead>
<tr>
<th>376-1155-00L</th>
<th>The Musculoskeletal System and Work</th>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>T. Läubli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.</td>
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<tr>
<td>Objective</td>
<td>Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal system during work. Prevention and rehabilitation of work related musculoskeletal disease will be discussed with the help of a bio-psycho-social model. Furthermore, evidence based methods for a healthy work design will be presented.</td>
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</tbody>
</table>
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in microscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature

376-1177-00L Human Factors I
Abstract
Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involves the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective
To learn and practice cybernetics principles in interface designs and product development.

Content
- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodation/vergence crosslink function
- Cross-link models in neurobiology- the oculomotor control system
- Human information processing in optimization of production lines

Literature

376-1179-00L Applications of Cybernetics in Ergonomics
Abstract
The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

Objective
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Content
- Neurogenesis
- Axon growth
- Synapse formation

Lecture notes
Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/as BIO344

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice
None. Bring something to write and your student ID

376-1305-00L Development of the Nervous System
Abstract
The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

Objective
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Content
- Neurogenesis
- Axon growth
- Synapse formation

Lecture notes
ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

Prerequisites / notice
Repetitionsprüfung 15. Juni 2016, HG E 26.1, 9-10.30h

376-1665-00L Structure, Plasticity and Repair of the Nervous System
Abstract
The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development

Objective
- To develop basics for a differential analysis of sports (model)
- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 162 of 1432
Content
Das Modell der Sportartenanalyse
Die Relevanz der einzelnen Leistungsfaktoren
Das Modell der Wettkampfanalyse
Folgerungen für das Training und Coaching in der Sportart
Folgerungen für das Nachwuchstraining
Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
Das Nachwuchs- und Talenttraining (Sichtung, Selektion, Förderung)
Projekte aus der Praxis (Talent- und Nachwuchstraining)
Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
Praxisbeispiele erarbeiten und planen
Konkrete Athletenbeobachtung

Lecture notes
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

Literature
Struktur sportlicher Leistung (Modellansatz von Gundlach; (Trainingswissenschaften S. 45 - 49; Stiehler/Konzag/Döbler)
Leistungsdiagnostische Verfahren, Stiehler/Konzag/Döbler
Trainingsfundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006
Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
Das neue Konditionstraining, Grosser/Starischka/Zimmermann, blv 2002
Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
Das neue Konditionstraining, Grosser/Starischka/Zimmermann, blv 2002
Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
Das neue Konditionstraining, Grosser/Starischka/Zimmermann, blv 2002

Prerequisites / notice
Kredit/Prüfung
Für die Kreditvergabe sind die vorgeschriebenen Semesterarbeiten und die Präsenz zwingend. Die Benotung erfolgt durch eine schriftliche Arbeit.
Planung
Die Planungsunterlagen werden zu Semesterbeginn abgegebenen, sind provisorisch und können vom Dozenten geändert werden. Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.
Die Semesterarbeit ist 4 Wochen nach Semesterbeginn abzugeben.

376-1716-00L Basics of Exercise Therapy
Number of participants limited to 30.

Possible from the 5th semester on.
Requirement:"Introduction of Exercise Therapy" passed.

Abstract
Basics of Exercise Therapy:
A: diagnostic, anamnesis, diagnostic of movement and function, assessments in exercise therapy, diagnostic of experience and behavior in relation to movement
B: biological-medical basics
biomechanic (joints), pathophysiological Basics (internal, orthopedic and psychological deseases).
C: didactic knowledge, Reha-didactic

Objective
Students learn the assessments to plan an exercise-therapy-treatment.
They are able to use them. They're able to integrate biological and medical basics.
They are able to prepare a therapy-session

Content
Grundlagen der Diagnostik, Anamnese, Bewegungsdagnostik, Funktionsdiagnostik
Sport- und Bewegungstherapeutische Testverfahren
Motorische Basisdiagnostik
Diagnostik bewegungsbezogenen Erlebens und Verhaltens
Biologisch-medizinische Grundlagen
Biomechanik (v.a. Gelenke), Pathophysiologische Grundlagen, Modelle der Methodik und Didaktik, Lektionsplanung

Lecture notes
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

Literature
-Schüle / Huber: Grundlagen der Sporttherapie, Deutscher Ärzteverlag , Köln 2012
- Deimel et al.: Neue aktive Wege in Prävention und Rehabilitation, Deutscher Ärzteverlag, Köln 2007

Prerequisites / notice
90% of the lections students must be present.

376-1717-00L Practical Basics in Sports and Exercise Therapy
Number of participants limited to 30.

Possible from the 5th semester on.
Requirement:"Introduction of Exercise Therapy" passed.

Abstract
Impart knowledge of practical basics of Sports and Exersice Therapy
The members are able to transform the knowledge from the previous courses in practical situations of Sports and Exercise Therapy. They learn basic aspects to design therapy lessons.

Content
communication/conversation with patients
psychoamnestic: relaxation
anatomy in vivo

Lecture notes
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

Literature
-Schüle / Huber: Grundlagen der Sporttherapie, Deutscher Ärzteverlag , Köln 2012
- Deimel et al.: Neue aktive Wege in Prävention und Rehabilitation, Deutscher Ärzteverlag, Köln 2007

Prerequisites / notice
The courses "Introduction in Sports and Exersice Therapy" and has been completed successfully.

376-1720-00L Application of MATLAB in the Human Movement Sciences

Abstract
Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).

Objective
Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.
To be provided by the individual lecturers, at their discretion. Handouts can be downloaded.

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including Biomechanics of Sports Injuries and Rehabilitation, Powerpoint presentations will be made available on-line to students.

This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. The nutrients are described in relation to digestion, bioavailability, metabolism and excretion with some focus on energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.

A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

376-1722-00L Spinal Cord Injury and Exercise W 2 credits 2V C. Perret

Abstract Intensive discussion concerning complications of a spinal cord injury and their consequences on trainability and exercise performance of persons sitting in a wheelchair. Overview on the clinical application of exercise testing as well as on the implementation of sport scientific findings to optimise performance of spinal cord injured subjects in rehabilitation and elite sports.

Objective Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

Content The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury; trainability/exercise physiology and spinal cord injury.

Literature General literature:


Prerequisites / notice Voraussetzung: Vorlesung Anatomie/Physiologie besucht!

376-2017-00L Biomechanics of Sports Injuries and Rehabilitation W 3 credits 2V K.U. Schmitt, J. Goldhahn

Abstract This lectures introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries.

Objective Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

Content This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

Lecture notes Handouts can be downloaded.


Prerequisites / notice A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

752-6001-00L Introduction to Nutritional Science W 3 credits 2V M. B. Zimmermann, C. Wolfrum

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

Objective To introduce the students to the both macro- and micronutrients in relation to food and metabolism.

Content The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

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


752-6101-00L Nutrition and Chronic Disease (HS) W 3 credits 2V M. B. Zimmermann

Abstract To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic disease.

Content The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular, disease, arthritis and food allergies.

Lecture notes There is no script. Powerpoint presentations will be made available on-line to students.

Literature To be provided by the individual lecturers, at their discretion.

Prerequisites / notice No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

752-6105-00L Epidemiology and Prevention W 3 credits 2V M. Eichholzer

Abstract

Objective

Content

Literature

Prerequisites / notice

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Students are able
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

**752-6151-00L** Public Health Concepts  
**W** 3 credits 2V R. Heusser

**Abstract**  
The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

**Objective**  
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

**Content**  
Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

**Lecture notes / notice**  
Handouts are provided to students in the classroom.

**Prerequisites / literature**  
Language of the course is English

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**752-6403-00L** Nutrition and Performance  
**W** 2 credits 2V S. Mettler, M. B. Zimmermann

**Abstract**  
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

**Objective**  
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

**Content**  
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

**Lecture notes / literature**  
Lecture slides and required handouts will be available on the ETH website.

**Prerequisites / notice**  
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

**Language:** English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

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**853-0033-00L** Leadership I  
**W** 3 credits 2V F. Kernic

**Abstract**  
The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

**Objective**  
The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

**Prerequisites / notice**  
The 1-hour written exam will take place during the last lecture in the semester.

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**151-0104-00L** Uncertainty Quantification for Engineering & Life Sciences  
**W** 4 credits 3G J. Beck, P. Kourmoutsakos

**Abstract**  
**Number of participants limited to 60.**

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

**Objective**  
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicores architectures.

**Content**  
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

**Lecture notes**  
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

**Literature**  
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia  
2. Probability Theory: The Logic of Science by E. T. Jaynes  
3. Class Notes

**Prerequisites / notice**  
Fundamentals of Probability, Fundamentals of Computational Modeling
Practical Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3010-00L</td>
<td>Practical Training I</td>
<td>O</td>
<td>15 credits</td>
<td>15P</td>
<td>C. Spengler</td>
</tr>
</tbody>
</table>

Abstract
3-months practical experience with topics from the major exercise physiology.

Objective
The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise physiology.

Content
The content of the practica is determined by the supervisor together with the student.

Prerequisites / notice
Practica can be combined with the master thesis. In such a case, it can only be started after the Bachelor Degree was obtained and the Vertiefungsleiter has approved the study.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3011-00L</td>
<td>Practical Training II</td>
<td>O</td>
<td>15 credits</td>
<td>15P</td>
<td>C. Spengler</td>
</tr>
</tbody>
</table>

Abstract
3-months practical work with topics from the major exercise physiology.

Objective
The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise physiology.

Content
The content of the practical work is determined by the supervisor together with the student.

Prerequisites / notice
Practical work can be combined with the master thesis. In such a case, it can only be started after the Bachelor Degree was obtained and the Vertiefungsleiter has approved the study.

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3100-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>30D</td>
<td>C. Spengler</td>
</tr>
</tbody>
</table>

Abstract
6-months research study with topics from the major exercise physiology.

Objective
The student shall apply his basic knowledge in a practical scientific study. He/she will be confronted with the requirements of scientific working. He/she must master this requirements.

Content
The content of the master thesis is determined by the supervisor together with the student. The thesis can begin only after the approval Vertiefungsleiter.

Prerequisites / notice
The master thesis can only be started after the Bachelor Degree was obtained and the Vertiefungsleiter has approved the study.

Sport Practical

For the entire offering see Sport Teaching Diploma.

see Sport Teaching Diploma, Sport Practical: Basic Education

see Sport Teaching Diploma, Sport Practical: Major Education

see Sport Teaching Diploma, Sport Practical: Education acquired outside ETH

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-HEST.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Human Movement Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>W+</th>
<th>Eligible for credits and recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Biology (General Courses)

Complementary Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>ZDr</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulilakos, A. Ferrari</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.</td>
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</tr>
<tr>
<td>Content</td>
<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Script as well as additional material in the form of hand-outs will be distributed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Lecture notes and references therein.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>376-1791-00L</td>
<td>Introductory Course in Neuroscience I</td>
<td>ZDr</td>
<td>2</td>
<td>2V</td>
<td>J.M. Fritschy, W. Knecht</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course gives an introduction to the development and anatomical and cellular structure of nervous systems. Furthermore, it discusses the basics of neurophysiology and neuropharmacology. Finally, the nervous system is described on a system level with a particular emphasis on the visual system.</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
| Content      | 1) Neuroanatomy I  
2) Neuroanatomy II  
3) Neurogenesis  
4) Axon guidance  
5) Action and language development  
6) Circadian rhythms  
7) Synaptic plasticity  
8) Synaptic transmission  
9) Neural circuits in vivo  
10) Visual pathways and visual processing  
11) Somatosensory system  
12) Vestibular system  
13) Sleep  
14) Learning and Memory, mice and human |      |       |       |                            |
| Prerequisites / notice | For doctoral students of the Neuroscience Center Zurich (ZNZ). |      |       |       |                            |
| 376-1795-00L | Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain)       | ZDr  | 2     | 2V    | J.M. Fritschy, H. U. Zeilhofer |
| Abstract     | The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience. |      |       |       |                            |
| Objective    | This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology. |      |       |       |                            |
| Prerequisites / notice | Für Doktorierende des Zentrums für Neurowissenschaften Zürich. Nicht für Master-Studierende geeignet. |      |       |       |                            |
| 551-1159-00L | Molecular Systems Biology                  | ZDr  | 0     | 1K    | U. Sauer, R. Aebersold    |
| Abstract     | Seminar series on current research topics in systems biology |      |       |       |                            |
| Objective    | An overview of systems biology research. Seminar series on current research topics in systems biology. |      |       |       |                            |
| Lecture notes| none                                       |      |       |       |                            |
| Literature   | none                                       |      |       |       |                            |
| 701-0265-00L | Ecology and Evolution                     | ZDr  | 2     | 2S    | E. Postma, J. Jokela      |
| Abstract     | A course dedicated to the reading and discussion of the relevant literature. The actual list of theme papers will be proposed anew for every year. Students then choose a topic and prepare themselves for a general discussion with their colleagues and peers. In the process, current and controversial topics will be discussed and studied. |      |       |       |                            |
| Objective    | To become proficient in reading scientific literature, to understand how to look at publications, to understand them and to be able to put them in context. The course also trains the skills needed for the presentation of scientific contributions and the ability to put things into a broader context. Training in how to participate in a scientific discussion, how to make an argument and how to listen to arguments of others. |      |       |       |                            |
| Content      | All topics focus on themes from ecology and evolution, notably so on studies on adaptation of organisms, their evolutionary history, or on questions of current methodology. |      |       |       |                            |
| Lecture notes| none                                       |      |       |       |                            |
| Literature   | The actual content, i.e. the theme papers, will be determined and allocated to the participants at the start of the course each year. Takes place at Uni Irchel. Please refer to notes on board or ask secretary Mrs. Rita Jenny (Rita.Jenny@env.etzh.ch). |      |       |       |                            |
| Prerequisites / notice | Requirements: Knowledge of ecology and evolution, e.g., lectures during basic and advanced study period. The course is meant for advanced and PhD students. |      |       |       |                            |
| 760-2211-00L | Colloquium Agricultural Science           | ZDr  | 0     | 2K    | E. Frossard, N. Buchmann, W. Grüttem, M. Kreuzer, O. Voinett, A. Walter, S. C. Zeeman |
| 151-0927-00L | Rate-Controlled Separations in Fine Chemistry | ZDr  | 4     | 3G    | M. Mazzotti                |
| Abstract     | The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology. |      |       |       |                            |
Objective
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content
The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Lecture notes
Handouts during the class

Literature
Recommendations for text books will be covered in the class

Prerequisites / notice
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

401-0649-00L
Applied Statistical Regression

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Lecture notes
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

227-1035-00L
Dynamical Systems in Biology

Objective
Applying concepts from nonlinear dynamics to biological systems. Combining theoretical modeling with supporting computer simulations.

Content
The course consists of a series of research seminars on Structural Biology, Biochemistry and Biophysics, given by both scientists of the National Center of Competence in Research (NCCR) in Structural Biology and external speakers. Information on the individual seminars is provided on the following websites:
http://www.structuralbiology.uzh.ch/educ002.asp
http://www.biol.ethz.ch/dbiol-cal/index

Objective
The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics.

551-1615-00L
NMR Methods for Studies of Biological Macromolecules

Prerequisites: Basic knowledge in biological NMR spectroscopy.

Objective
Introduction and discussion of advanced methods for recording and analysis of NMR data with biological macromolecules.

Content
Seminar series on technical aspects of high resolution nuclear magnetic resonance (NMR) spectroscopy with biological macromolecules.

551-1619-00L
Structural Biology

Objective
The course consists of a series of research seminars on Structural Biology, Biochemistry and Biophysics, given by both scientists of the National Center of Competence in Research (NCCR) in Structural Biology and external speakers. Information on the individual seminars is provided on the following websites:
http://www.structuralbiology.uzh.ch/educ002.asp
http://www.biol.ethz.ch/dbiol-cal/index

Objective
To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.
The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health and Disease Research, will present a paper by one of the research groups in their area of expertise. The students are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they are available on the course web site). You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Students and researchers can get advice for analyzing scientific data, often for a thesis. The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons. There are no exams nor credits. We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data! Handouts with reproductions of all presented transparencies will be distributed.

**Course language is English or German and may depend on the speaker.**

About 5 talks on applied statistics.

The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons. Advice for analyzing data by statistical methods. Students and researchers can get advice for analyzing scientific data, often for a thesis. You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they are available on the course web site). You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

## Objective

Students are able to describe selected chemicals, biological and molecular processes that occur in cells spontaneously or after physical or chemical exposure and resulting in a tumor. They are able to list important cancer-inducing agents and explain the respective mechanism of action. They have knowledge of significant risk factors for cancer diseases. They are confronted with the basics of toxicology and they can explain the principle of the most common therapeutic strategies.

## Content

The lecture deals with problems of tumor epidemiology (causes, mortality, incidence). Cancer is delineated as a multi-step process. Classes of chemical compounds that induce cancer are discussed as well as the reactive metabolites that may be built from. Covalent binding to DNA is discussed and different types of mutations resulting thereof. A selection of proto-oncogenes and tumor suppressor genes is presented. Their function will be discussed as well as the changes which are found in these genes in tumor cells, starting from single nucleotide exchanges up to large deletions. The reason for genetic predisposition to cancer will be discussed as well as cancer relevant aspects of cell cycle regulation. Phenomenons like angiogenesis and metastasis are presented as well as the mechanisms that protect the genome from mutagenic damage. Further subjects address old and new strategies of cancer treatment. Personalised cancer treatment.

## Literature


## Additional Information

Contact: beratung@stat.math.ethz.ch . Tel. 044 632 2223. See also http://stat.ethz.ch/consulting

Requirements: Knowledge of the basic concepts of statistics is desirable.

## Lecture notes

Handouts with reproductions of all presented transparencies will be distributed.

**Course language is English or German and may depend on the speaker.**

About 5 talks on applied statistics.

The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons. Advice for analyzing data by statistical methods. Students and researchers can get advice for analyzing scientific data, often for a thesis. You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they are available on the course web site). You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

## Literature


## Additional Information

Contact: beratung@stat.math.ethz.ch . Tel. 044 632 2223. See also http://stat.ethz.ch/consulting

Requirements: Knowledge of the basic concepts of statistics is desirable.
Abstract
This monthly meeting is a platform for Zurich-based immunology research groups to present and discuss their ongoing research projects. At each meeting three PhD students or Postdocs from the participating research groups present an ongoing research project in a 30 min seminar followed by a plenary discussion.

Objective
The aim of this monthly meeting is to provide further education for master and doctoral students as well as Postdocs in diverse topics of immunology and to give an insight in the related research. Furthermore, this platform fosters the establishment of science- and technology-based interactions between the participating research groups.

Content
Presentation and discussion of current research projects carried out by various immunology-oriented research groups in Zurich.

Prerequisites / notice
Presented project data are confidential. Sign-up for seminar announcements by emailing pilhofer@biol.ethz.ch.

Biology (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td></td>
<td>G</td>
<td>lecture with exercise</td>
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<td>seminar</td>
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<td>colloquium</td>
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<tr>
<th>Key for Credits</th>
<th>W</th>
<th>Eligible for credits</th>
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<tbody>
<tr>
<td>Dr</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>O</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0291-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6 credits</td>
<td>4V+2U</td>
<td>A. Caspar</td>
</tr>
</tbody>
</table>

**Abstract**
Mathematics I/II is an introduction to one- and multidimensional calculus and linear algebra emphasizing on applications.

**Objective**
Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences. Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.

**Content**

### Eindimensionale diskrete Entwicklungen ##
- linear, exponentiell, begrenzt, logistisch
- Fixpunkte, diskrete Veränderungsrate
- Folgen und Grenzwerte

### Funktionen in einer Variablen ##
- Reproduktion, Fixpunkte,
- Periodizität,
- Stetigkeit

### Differentialrechnung (I) ##
- Veränderungsrate/-geschwindigkeit
- Differentialquotient und Ableitungsfunktion
- Anwendungen der Ableitungsfunktion

### Integralrechnung (I) ##
- Stammfunktion
- Integrationstechniken

### Gewöhnliche Differentialgleichungen (I) ##
- Qualitative Beschreibung an Beispielen:
  - Beschränkt, Logistisch, Gompertz
- Stationäre Lösungen
- Lineare DGL 1. Ordnung
- Trennung der Variablen

### Lineare Algebra ##
- Erste Arithmetische Aspekte
- Matrizenrechnung
- Eigenwerte / -vektoren
- Quadratische LGS und Determinante

**Lecture notes**
In Ergänzung zu den Vorlesungskapiteln der Lehrveranstaltungen fassen wir wichtige Sachverhalte, Formeln und weitere Ausführungen jeweils in einem Vademecum zusammen. Die pdfs finden Sie unter Lernmaterial > Dokumente.

Dabei gilt:

* Die Skripte ersetzen nicht die Vorlesung und/oder die Übungen!
* Ohne den Besuch der Lehrveranstaltungen verlieren die Ausführungen ihren Mehrwert.
* Details entwickeln wir in den Vorlesungen und den Übungen, um die hier bestehenden Lücken zu schliessen.
* Prüfungsrelevant ist, was wir in der Vorlesung und in den Übungen behandeln.

**Literature**

- **Th. Wihler**
  Mathematik für Naturwissenschaften, 2 Bände: Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB.

- **H. H. Storrer**
  Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser. Via ETHZ-Bibliothek: http://link.springer.com/book/10.1007/978-3-0348-8598-0/page/1

- **Ch. Blatter**
  Lineare Algebra; VDF auch als [pdf](http://www.math.ethz.ch/~blatter/dlp.html)
### Prerequisites / notice
+ Die Übungsaufgaben (inkl. Multiple-Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung.
+ Es wird erwartet, dass Sie mindestens 75 % der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.
+ Der Prüfungstoff ist eine Auswahl von Themen aus Vorlesung und Übungen. Für eine erfolgreiche Prüfung ist die konzentrierte Bearbeitung der Aufgaben unerlässlich.

## 252-0852-00L  Foundations of Computer Science  O  4 credits  2V+2U  J. Hromkovic, H.J. Böckenhauer, M. Dahinden, L. E. Fässler, D. Komm

**Abstract**
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

**Objective**
- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

**Content**
1. The role of computer science in science
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

**Lecture notes**
All materials for the lecture are available at www.gdi.ethz.ch

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

## 551-0105-00L  Fundamentals of Biology IA  O  5 credits  5G  M. Aebi, E. Hafen

**Abstract**
The course provides an introduction to the basics of molecular- and cell biology and genetics.

**Objective**
Introduction to modern biology and to principal biological concepts.

**Content**
The course is divided into several chapters:
1. Basic principles of Evolution.
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell: structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

**Lecture notes**
None.

**Literature**
The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course.

The structure of the course is largely identical with that of the text-book.

**Prerequisites / notice**
Certain sections of the text-book must be studied by self-instruction.

## 529-1001-01L  General Chemistry (for Biology/Pharmacy/HST)  O  4 credits  4V  W. Uhlig

**Abstract**
The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

**Objective**
The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.

**Content**
The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

**Literature**
- Weiterführende Literatur:
  - Brown, LeMay, Bursten CHEMIE (deutsch)
  - Housecroft and Constable, CHEMISTRY (englisch)
  - Octoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

## 529-1011-00L  Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci. & Tech.)  O  4 credits  4G  C. Thilgen

**Abstract**
Fundamentals of Organic Chemistry: molecular structure. Bonding and functional groups; nomenclature; resonance and aromaticity; stereochemistry; conformation; bond strength; organic acids and bases; basic reaction thermodynamics and kinetics; reactive intermediates: carbanions, carbenium ions and radicals.

Objective

Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Understanding the relationship between structure and reactivity.

Content


Lecture notes

Printed lecture notes are available. Exercises, answer keys and other handouts can be downloaded from the Moodle course “Organic Chemistry I” of the current semester (https://moodle-app2.let.ethz.ch).

Literature

Lecture notes are available.

Supplementary textbooks:


Prerequisites / notice

The course consists of plenary lectures (2 h per week) and problem-solving lessons (2 h per week, groups of ca. 25 people). In addition, online exercises are available in the e-learning environment Moodle (Course OC I).

First Year Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-1001-00L</td>
<td>Laboratory Course General Chemistry (for Biology and Pharmacy)</td>
<td>O</td>
<td>6 credits</td>
<td>8P</td>
<td>R. O. Kussner, K.H. Altmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle</td>
</tr>
</tbody>
</table>

Abstract

Introduction to the practical work in a chemistry laboratory. The most important manipulations and techniques are treated, as well as the most fundamental chemical reaction types.

Objective

- Knowledge of the basic chemical laboratory methods.
- Basic knowledge of the scientific approach in experimenting.
- Observation and interpretation of real-world chemical processes.
- Keeping of a reliable laboratory journal.

Content

- Simple chemical methods and calculations.
- Separation techniques.
- Simple physical measurements.
- Ionic solids (salts).
- Acid/Base chemistry, buffers.
- Redox reactions.
- Metal complexes.
- Titration methods.
- Introduction to qualitative analysis.

Lecture notes

Course manual (is handed out to the students at the begin of the lessons).

Language: German, English upon request.

Literature


is a suitable textbook.

Prerequisites / notice

This practical course causes costs for materials and chemicals. The costs are charged to the students at the end of semester.

Second Year Courses

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1023-00L</td>
<td>Physical Chemistry I (for Biology and Pharmacy)</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>R. Riek, H. P. Lüthi</td>
</tr>
</tbody>
</table>

Abstract


Objective

Understanding the fundamental thermodynamical properties of chemical and biological systems.

Content


Lecture notes

In process, will be distributed at the beginning of the first lecture.

Literature


Prerequisites / notice

Prerequisite: mathematics I-II, functions of multiple variables, partial derivatives.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0103-00L</td>
<td>Fundamentals of Biology II: Cell Biology</td>
<td>O</td>
<td>5 credits</td>
<td>5V</td>
<td>E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner</td>
</tr>
</tbody>
</table>

Abstract

The goal of this course is to provide students with a wide general understanding of cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Objective

The goal of this course is to provide students with a wide general understanding of cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Lecture notes

The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

Prerequisites / notice
Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

551-1323-00L
Fundamentals of Biology II: Biochemistry and Molecular Biology

Abstract
The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects. Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycan, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

Objective

529-1011-00 G "Organische Chemie I (für Biol./Pharm.Wiss.)"

Prerequisites / notice
Some of the lectures are given in the English language.

551-1003-00L
Methods of Biological Analysis

Abstract
Principles of the most important separation techniques and the interpretation of molecular spectra.

Objective
Knowledge of the necessary basics and the possibilities of application of the relevant spectroscopical and separation methods in analytical chemistry.

Content
Application oriented basics of instrumental analysis in organic chemistry and the empirical employment of the methods of structure elucidation (mass spectrometry, NMR-, IR-, UV/Vis spectroscopy). Basics and application of chromatographic and electrophoretic separation methods. Application of the knowledge by practising.

Prerequisites / notice

Lecture notes
A comprehensive script is available in the HCI-Shop. A summary of the part "Spektroskopie" defines the relevant material for the exam.

551-0435-00L
Introduction to Evolutionary Biology

Abstract
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution.

Objective

Prerequisites / notice

Lecture notes

Literature

401-0643-13L
Statistics II

Abstract
Vertiefung von Statistikmethoden. Nach dem detailierten Fundament aus Statistik I liegt nun der Fokus auf konzeptuelle Breite und konkreter Problemlösungsfähigkeit mit der Statistiksoftware R.

Objective

Prerequisites / notice

Elective Blocks

Biodiversity

701-0245-00L
Introduction to Evolutionary Biology

Abstract
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

Objective

Content
Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

Literature
Textbook: Evolutionary Analysis

Scott Freeman and Jon Herron

Prerequisites / notice
The exam is based on lecture and textbook.

551-0435-00L
Systematic Biology: Zoology

Abstract
Lecture: The lecture provides an overview of animal diversity. Using key selected groups, phylogenetic, morphological and ecological aspects are addressed. Two priority topics are the arthropods and the vertebrates (including vertebrate fauna of Switzerland).

Practical: Knowledge of selected animal groups and their characteristics (supplementing the lecture) and of the basic methods.
Objective

Lecture: The systematic classification of animals and the characteristics of the most important animal groups, basic animal body plans.

Practical: Examples of selected animal groups and their characteristics; acquire the relevant skills: simple preparations, dissection, microscopy, drawing, protocols.

Content

Lecture: Body plans, characteristics, diversity and phylogenetic position of the main groups of Protozoa, Invertebrates, and Vertebrates, with a special focus on Arthropods and Vertebrates (including vertebrate fauna of Switzerland).

Practical: Macroscopic and microscopic study of selected Protozoa, Invertebrates (especially insects) and Vertebrates: morphology and anatomy; behaviour, mainly locomotion, feeding, and reproduction.

Lecture notes

A script for the course will be sold in the lecture, and additional material will be handed out (particularly in the practical).

Literature

No further literature required, the script contains suggestions for further reading.

551-0227-00L Mycology

Abstract

The lecture gives an introduction into the field of Mycology. It provides an overview of the fungal lifestyle (hyphal growth/mycelium; reproductive cycles; ecology of the fungi; use of fungi).

Objective

Understanding the fungal life form.

Knowledge of the specific properties of the fungal cell

Knowledge of the different reproductive cycles in all fungal phyla

Knowledge of the different nutritional modes of the fungi; correlation with habitat and ecology

Knowledge of the application of fungi in food production and biotechnology

Content

The lecture focuses on the following topics within Mycology:

1. The fungal lifestyle
2. Differentiation processes of the Mycelium
3. Reproductive cycles and systematic grouping of fungi
4. Ecology of the fungi
5. Use of fungi

Lecture notes

none; hand-outs will be prepared before the lectures

Literature

none

Prerequisites /

none

Cellular and Molecular Biology

Number Title Type ECTS Hours Lecturers

701-0245-00L Introduction to Evolutionary Biology O 2 credits 2V G. Velicer, S. Wielgoss

Objective

This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

Content

This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution.

Literature

Textbook: Evolutionary Analysis

Scott Freeman and Jon Herron


Prerequisites / notice

The exam is based on lecture and textbook.

529-0229-00L Practical Course Organic Chemistry (for Students of Biology and Pharmaceutical Sciences)

Abstract

Latest online enrolment is one week before the beginning of the semester.

Objective

Synthetic part: at least 8 synthetic steps (one- or two-step syntheses).

Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography).

Learn to take accurate notes of the experiments.

Deepen the understanding of reaction mechanisms.

Content

Analytical part: practical operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography).

Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

Introduction to database searches (Reaxys, SciFinder).

Prerequisites / notice

The basic reactions of Organic Chemistry and their mechanisms should be known (cf. course 529-1012-00L Organic Chemistry II for Students of Biological, Pharmaceutical Sciences, and Health Sci. and Tech.).

As a prerequisite, all participants need to pass the "Safety Test HCI Chemie_V2 English" (see https://moodle-app2.let.ethz.ch). A printout of the certificate generated by the system needs to be presented to the teaching assistants prior to starting lab work.

Biological Chemistry

Number Title Type ECTS Hours Lecturers

529-0229-00L Practical Course Organic Chemistry (for Students of Biology and Pharmaceutical Sciences)

Latest online enrolment is one week before the beginning of the semester.
Abstract
Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography).

Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

Objective
Learn the basic techniques for the preparation and purification of organic compounds.
Learn to take accurate notes of the experiments.
Deepen the understanding of reaction mechanisms.

Content
Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography).
Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).
Introduction to database searches (Reaxys, SciFinder).

Lecture notes
Documentation will be handed out at the beginning of the course.

Literature
1) P. Wörfel, M. Bitzer, U. Claus, H. Felber, M. Hübel, B. Vollenweider, Laborpraxis (Bd. 1: Einführung, allgemeine Methoden; Bd. 2: Messmethoden; Bd. 3: Trennungsmethoden; Bd. 4: Analytische Methoden), Birkhäuser Verlag.

Prerequisites / notice
The basic reactions of Organic Chemistry and their mechanisms should be known (cf. course 529-1121-00L Organic Chemistry II for Students of Biology, Pharmaceutical Sciences, and Health Sci. and Tech.).

As a prerequisite, all participants need to pass the "Safety Test HCI Chemie_V2 English" (see https://moodle-app2.let.ethz.ch). A printout of the certificate generated by the system needs to be presented to the teaching assistants prior to starting lab work.

529-1121-00L Inorganic Chemistry (for Biology)

Abstract
Orbitals and chemical bonding in main-group elements and transition metals.

Objective
Introduction to the orbital concept and to the bonding theory in complexes of the transition metals.

Content

Lecture notes
Can be bought at the HCI-shop.

Literature

3. Year, 5. Semester

Concept Courses, 5. Semester

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
701-2413-00L | Evolutionary Genetics | W | 6 credits | 4V | T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer, A. Guggisberg

Abstract
The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

Objective
The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

Content
Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding, natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics; neutral theory of molecular evolution and basics of coalescent theory.
Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher's fundamental theorem.
Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation.

Lecture notes
Handouts

Literature

Prerequisites / notice
There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

551-0307-00L Biomolecular Structure and Mechanism I: Protein Structure and Function

Abstract
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAs, current topics in protein biophysics and structural biology.

Objective
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Literature
- Creighton, T.E., Proteins (5th edition), Freeman (2001);
- Berg, Tymoczko, Stryer: Biochemistry (5th edition), Freeman (2001);
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

551-0309-00L Concepts in Modern Genetics

Abstract
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective
This course focuses on the concepts of classical and modern genetics and genomics.

Content
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes
Scripts and additional material will be provided during the semester.
The advanced course introduces students to plants through a concept-based discussion of developmental processes that integrates physiology and biochemistry with genetics, molecular biology, and cell biology. The course follows the life of the plant, starting with the seed, progressing through germination to the seedling and mature plant, and ending with reproduction and senescence.

The new course "Molecular Life of Plants" reflects the rapid advances that are occurring in the field of experimental plant biology as well as the changing interests of students being trained in this discipline. Contemporary plant biology courses emphasize a traditional approach to experimental plant biology by discussing discrete topics that are removed from the context of the plant life cycle. The course will take an integrative approach that focuses on developmental concepts. Whereas traditional plant physiology courses were based on research carried out on intact plants or plant organs and were often based on phenomenological observations, current research in plant biology emphasizes work at the cellular, subcellular and molecular levels.

The goal of "Molecular Life of Plants" is to train students in integrative approaches to understand the function of plants in a developmental context. While the course focuses on plants, the training integrative approaches will also be useful for other organisms.

Plant genome organization
Seed anatomy
Food reserves and mobilization
Seeding emergence
Heterotrophic to autotrophic growth
Chlorophyll biosynthesis, photoreceptors
Integration of metabolism
Hormones
Cell cycle
Cell differentiation and expansion
Environmental interactions
Environmental interactions
Flower development and fertilization
Embryo and seed development
Fruit development
Senescence

551-0311-00L Molecular Life of Plants W 6 credits 4V

Abstract
The advanced course introduces students to plants through a concept-based discussion of developmental processes that integrates physiology and biochemistry with genetics, molecular biology, and cell biology. The course follows the life of the plant, starting with the seed, progressing through germination to the seedling and mature plant, and ending with reproduction and senescence.

Objective
The new course "Molecular Life of Plants" reflects the rapid advances that are occurring in the field of experimental plant biology as well as the changing interests of students being trained in this discipline. Contemporary plant biology courses emphasize a traditional approach to experimental plant biology by discussing discrete topics that are removed from the context of the plant life cycle. The course will take an integrative approach that focuses on developmental concepts. Whereas traditional plant physiology courses were based on research carried out on intact plants or plant organs and were often based on phenomenological observations, current research in plant biology emphasizes work at the cellular, subcellular and molecular levels.

The goal of "Molecular Life of Plants" is to train students in integrative approaches to understand the function of plants in a developmental context. While the course focuses on plants, the training integrative approaches will also be useful for other organisms.

Content
The course "Molecular Life of Plants" will cover the following topics in a developmental context:

- Plant genome organization
- Seed anatomy
- Food reserves and mobilization
- Seeding emergence
- Heterotrophic to autotrophic growth
- Chlorophyll biosynthesis, photoreceptors
- Integration of metabolism
- Hormones
- Cell cycle
- Cell differentiation and expansion
- Environmental interactions
- Environmental interactions
- Flower development and fertilization
- Embryo and seed development
- Fruit development
- Senescence

551-0313-00L Microbiology (Part I) W 3 credits 2V

Abstract
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective
This concept class will be based on common concepts (Grundlagen der Biologie II, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes
Updated handouts will be provided during the class.

Literature
Current literature references will be provided during the lectures.

551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

529-0731-00L Nucleic Acids and Carbohydrates W 6 credits 3G

Abstract
Structure, function and chemistry of nucleic acids and carbohydrates, DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Objective
Structure, function and chemistry of nucleic acids and carbohydrates, DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Content
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Lecture notes
Mainly based on recent original literature, a detailed list will be distributed during the first lecture.
Food Microbiology I  
W  3 credits  2V  M. Loessner

Abstract
This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

Objective
The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

Content
1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
2. Overview of Microorganisms in Foods
   2.1. Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download.

Literature
Recommendations will be given in the first lecture.
Objective
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content
Bioinformatics I will cover the following topics:
- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

376-1305-00L Neurobiology W 6 credits 4V M. E. Schlab, E. Stoeckli, L. Filli,
K. A. Martin, further lecturers

Abstract
Development of the nervous system (NS); the adult NS, plasticity and regeneration, sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, diseases of the NS.

Objective
Overview of normal development, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
Development: Early development of the nervous system, cellular level, nerve fiber growth, building of neuronal networks; biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
Structure, Plasticity and Repair of the Nervous System (376-1305-01L); Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Literature
Development of the Nervous System (376-1305-00L); Lecture notes will be provided on OLAT https://www.olat.uzh.ch/olat/dmz/

701-1415-00L Population Biology W 3 credits 2V

Abstract
This course provides an understanding of the basic concepts of population biology. It presents models regarding the dynamics and evolution of populations, and experimental designs for investigating population biology hypotheses (e.g., population growth, species interactions, epidemiology, metapopulations, life history evolution, local adaptation, evolution of sex, and coevolution).

Objective
Students are able
- to describe and apply population biology models (e.g. growth, species interactions)
- to describe and apply epidemiological models
- to substantiate evolutionary concepts (e.g., life history evolution, coevolution, evolution of sex) using population biology arguments and provide examples
- to propose population biology experiments

Content
Population growth, population regulation, predator-prey interactions, host-pathogen interactions, competition, metapopulations, life history evolution, local adaptation, mating systems, sexual selection, coevolution.

Lecture notes
Recommended: Handouts of lectures

Literature

376-0205-00L Molecular Disease Mechanisms I W 6 credits 4V C. Wolfrum, C. Ciaudo, M. Ristow, M. Stoffel, A. Wutz, M. Zenobi-Wong

Abstract
The mechanisms of disease development will be studied. Main topics will be: Genetic regulation of disease development with a focus on monogenic and polygenic forms. In addition the methods used in elucidating genetic components in disease progression will be discussed. Ageing and development associated disease progression including the underlying molecular mechanisms.

Objective
To understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components to understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components.

701-0323-00L Plant Ecology W 3 credits 2V S. Güsewell, J. Levine

Abstract
This class focuses on ecological processes involved with plant life, mechanisms of plant adaptation, plant-animal and plant-soil interactions, plant strategies and implications for the structure and function of plant communities. The discussion of original research examples familiarises students with research questions and methods; they learn to evaluate results and interpretations.

Objective
Students will be able to:
- propose methods to study ecological processes involved with plant life, and how these processes depend on internal and external factors;
- analyse benefits and costs of plant adaptations;
- explain plant strategies with relevant traits and trade-offs;
- explain and predict the assembly of plant communities;
- explain implications of plant strategies for animals, microbes and ecosystem functions;
- evaluate studies in plant ecology regarding research questions, assumptions, methods, as well as the reliability and relevance of results.
Practical Aspects of Plant Biotechnology

This course presents essential processes and plant traits involved with plant life. We focus on research questions that have been of special interest to plant ecologists as well as current topical questions. We use original research examples to discuss how ecological questions are studied and how results are interpreted.

- Growth: what determines the production of a plant?
- Nitrients: consumption or recycling: opposite strategies and feedbacks on soils;
- Clonality: collaboration and division of labour in plants;
- Plasticity: benefits and costs of plant intelligence;
- Flowering and pollination: how expensive is sex?
- Seed types, dispersal, seed banks and germination: strategies and trade-offs in the persistence of plant populations;
- Development and structure of plant populations;
- Stress, disturbance and competition as drivers of different plant strategies;
- Herbivory: plant-animal feedbacks and functioning of grazing ecosystems
- Fire: impacts on plants, vegetation and ecosystems.
- Plant functional types and rules in the assembly of plant communities.

Lectures and handouts are normally in German, but we shall switch to English on request. Non German-speaking students who intend to attend the course should contact S. Güsewell before the start of the semester to ask for the change in language.

Prerequisites
- General knowledge of plant functioning (Biologie I-II)
- General ecological concepts (Biologie III)
- Overview of plant taxonomy and vegetation types (Biologie IV)

Block Courses, 5. Semester

Registration for Block courses is mandatory. Please register under https://www.uzh.ch/zoolmed/ssl-dir/Blockkurse_UNIETH.php . Registration period: from 27.7.2015 to 9.8.2015

Block Courses in 1st Quarter of the Semester

From 15.9.2015, 13:00 hr to 7.10.2015, 17:00 hr

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>551-0333-00L</td>
<td>Biodiversity and Ecological Significance of Fungi</td>
<td>W</td>
<td>6</td>
<td>7P</td>
<td>Leuchtmann, R. Berndt, Senn-Irlet</td>
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<td>Number of participants limited to 8.</td>
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Abstract
Introduction to the biology, systematics and ecology of the important fungal groups. The participants will study primarily fungal materials that they collect during field excursions or that they isolate in the laboratory.

Objective
Knowledge of characteristics, life style and ecological significance of major fungal and fungal-like groups. Become acquainted with methods for collecting, microscopic examination and identification of fungi.

Content

Auf mehreren Ausflügen werden wir die Vielfalt und Ökologie der Pilze am natürlichen Standort studieren. Die Ausflüge dienen auch dem Sammeln von Material, an dem wir im Kurs die Mikroskopie und Präparation der Pilze üben werden.

Lecture notes
Übersichten und Skriptunterlagen zum Kursstoff werden abgegeben.

Literature


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<tr>
<td>551-0191-00L</td>
<td>Practical Aspects of Plant Biotechnology</td>
<td>W</td>
<td>6</td>
<td>7G</td>
<td>K. Bärenfalter, J. Fütterer</td>
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Abstract
The course covers multidisciplinary aspects of plant molecular biology and green biotechnology. The participants will acquire theoretical and practical introduction on diverse topics, including generation and molecular characterization of transgenic plants, allele mining from genetic resources and on strategies to improve plants against biotic & abiotic stresses and for their nutritional value.

Objective
In this block course, students will gain conceptual and practical introduction to crop biotechnology research. In addition to the theoretical overview of current trends in plant biotechnology, students will envision the practical application of the knowledge gained through hands-on training on the plant molecular biology laboratory techniques. The course will introduce the potential of plant molecular biology and genetic transformation as a tool for gene identification, gene function, crop improvement and commercial application. The course will also allow the students to understand and critically evaluate the literature in this research field.

Content
Lectures will particularly focus on the contribution of biotechnology towards crop improvement, with examples from our own work on crops including rice and wheat.

Following topics will be covered:
- Green biotechnology: status and prospects
- Plant genetic transformation (methods)
- Molecular characterization of transformed plants
- Introduction to selection marker systems (examples, antibiotic and herbicide resistance, phosphomannose-isomerase, marker-free systems, visible markers)
- Introduction to promoter types (example tissue specific promoters)
- Plant tissue culture techniques
- Crop improvement through biotechnology (examples from our work on rice, wheat and cassava)
- Gene/allele mining from plant genetic resource collections

A visit to the ETH greenhouse facilities at Eschikon will provide an opportunity to visualize and discuss different rice, wheat and cassava projects performed at the ETH Plant Biotechnology Lab.

Lecture notes
For the practical part, protocols will be distributed within the course and Lecture material will be made available.

Literature
Relevant literature information will be provided within the course.

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<tbody>
<tr>
<td>551-0193-00L</td>
<td>Biological Information Mining</td>
<td>W</td>
<td>6</td>
<td>7G</td>
<td>K. Bärenfalter, J. Fütterer</td>
</tr>
<tr>
<td>Number of participants limited to 8.</td>
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Abstract
Students will use lists of genes obtained in real experiments and learn how to obtain gene-centered information from literature and databases. They will use tools for gene function prediction and visualization of protein-protein interaction networks. The work will lead to a more meaningful annotation of co-detected genes and generate a hypothesis about their functional relationship.
There will be optional papers to be read before the course start. They serve as framework orientation for the practical parts of this block.

Type

During this Block-Course, the students will learn to

The course aims at introducing principles of synthetic biology related to metabolic engineering. The main focus is on practical work and will

7G

Knowledge of the fungi of forest and its ecological significance. Knowing of current methodological research approaches. Self-reliant and

Lecturers

Mechanisms of Bacterial Pathogenesis

I. L. Brunner

Provides an overview on student's learning and shows ways to make the classroom experience more engaging and effective for students.

6 credits

Learning and Teaching Biology

J. Vorholt-Zambelli

In the course students will use lists of genes or proteins from ongoing experiments in the laboratory and learn how to find and assemble genome-centered information in the literature, different databases and with analysis tools. The training and research will lead to a better and more meaningful annotation of co-detected genes members and generate a hypothesis about their functional relationship. The work will be done exclusively using a computer. Students will work independently but with close supervision by experienced scientists. Daily discussions of the work will ensure progress. The computer work will be accompanied by lectures on theoretical and practical aspects of databases, gene networks and the project context of the gene lists that will be analyzed. Students will present their results and hypotheses at the end of the block course.

551-0347-00L

Molecular Mechanisms of Cell Growth and Polarity

W. 6 credits
R. Kroschewski, Y. Barral,
S. Jessberger, M. Peter, A. Wutz

Abstract

Introduction to the principles and molecular mechanisms of cell polarity, using animal cells and fungi as model systems.

Objective

The students learn to describe the principles and molecular mechanisms of cell polarity, using different model systems as examples:
- Animal cells during epithelial and neuronal differentiation
- Fungi during morphogenesis and aging.

Based on lectures, literature reading, discussions, presentations and practical lab work the students will be able to compare experimental strategies in different model systems, and to develop open questions in the field of cell polarity. Students will also know about the mechanisms and consequences of asymmetric cell division such as those performed by stem cells and asymmetric protein functions during morphogenesis and aging.

Content

During this Block-Course, the students will learn to
(1) describe and compare the principles and molecular mechanisms of cell polarity in fungi and animal cells,
(2) apply, evaluate and compare experimental strategies in the different model systems, and
(3) select the best model system to answer a particular question.

Students - in groups of 2 or max 3- will be integrated into a research project connected to the subject of the course, within one of the participating research groups.

Lecture notes

There will be optional papers to be read before the course start. They serve as framework orientation for the practical parts of this block course and will be made accessible to you shortly before the course starts on the relevant Moodle site.

Literature

Documentation and recommended literature (review articles) will be provided during the course.

551-1129-00L

Engineering Bacterial Metabolism

W. 6 credits
J. Vorholt-Zambelli

Abstract

This laboratory course has a focus on current research topics related to metabolic engineering / synthetic biology. Projects will be conducted in small groups.

Objective

The course aims at introducing principles of synthetic biology related to metabolic engineering. The main focus is on practical work and will familiarize with complementary approaches, in particular genetic, biochemical and analytical approaches. Scientific presentation of results.

Content

The projects will involve the selection of enzymes and pathways for integration into foreign host metabolism and testing of their activity. Experimental work applied during the course will comprise e.g. creation of synthetic operons, cloning work, transformation, enzyme activity tests, dynamic 13C labeling experiments. The course will be linked to ongoing research projects in the laboratory.

Lecture notes

None

Literature

Will be provided at the beginning of the course.

551-0916-00L

Learning and Teaching Biology

W. 6 credits
E. Hafen, M. Klymkowsky

Abstract

This course represents an introduction to recent research into student learning on the conceptual foundations of modern biology, together with pedagogical methods associated with effective instruction and its valuation. Students will be involved in active research into conceptual and practical issues involved in biology education and methods to discover student preconceptions.

Objective

Provides an overview on student's learning and shows ways to make the classroom experience more engaging and effective for students. Students will learn to produce a research-based paper on a project they work on during the course.

Content

The course is not taught by a particular book, but recommended literature (review articles and selected primary literature) will be provided during the course.

See the introductory video to the course here: http://youtu.be/GFJuNncSsdE

Block Courses in 2nd Quarter of the Semester

From 8.10.2015, 08:00 hr to 30.10.2015, 17:00 hr

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>551-0345-00L</td>
<td>Mechanisms of Bacterial Pathogenesis</td>
<td>W</td>
<td>6 credits</td>
<td>7P</td>
<td>W.D. Hardt</td>
</tr>
<tr>
<td>551-0421-00L</td>
<td>Biology and Ecology of Fungi in Forests</td>
<td>W</td>
<td>6 credits</td>
<td>7G</td>
<td>I. L. Brunner, S. H. Egli, D. H. Rigling</td>
</tr>
</tbody>
</table>

Lecture notes

Number of participants limited to 8.

Abstract

Research laboratory class in small groups. Research projects on current topics in cellular microbiology and bacterial pathogenesis are assigned to each student.

Objective

Introduction to a current topic in cellular microbiology and/or molecular genetics of a bacterial pathogen. Experimental work in the research lab and introduction to the current technical techniques. Work with the current research literature in bacterial pathogenesis. Writing of a research protocol.

Content

Research projects on the model pathogen Salmonella.

Literature

Literature will be selected with reference to the assigned research project.

Number of participants limited to 10.

Abstract

Introduction of the biological and ecological basics of fungi in forests. Focusing on mycorrhizal, saprobic, and pathogenic fungi and their functional relevance in the forest ecosystems. To get to know current methodological research approaches on the basis of selected examples with practical works in forest and lab as well as excursions and lectures.

Objective

Knowledge of the fungi of forest and its ecological significance. Knowing of current methodological research approaches. Self-reliant and deepened activities of selected topics of fungi from forests.

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 182 of 1432
Introduction of the biological and ecological basics of fungi in forests. Focusing on mycorrhizal, saprobic, and pathogenic fungi and their functional relevance in the forest ecosystems. To get to know current methodological research approaches on the basis of selected examples with practical works in forest and lab as well as excursions and lectures.

**Literature**


**Prerequisites / notice**

Der Blockkurs findet an der Eidg. Forschungsanstalt WSL in Birmensdorf statt. Der Wald vor der Haustüre des Institutes macht diesen Kurs besonders praxisnah.

Erreichbarkeit mit Tram 14 bis Triemli, danach PTT-Bus 220 oder 350 bis Birmensdorf Sternen/WSL, oder mit S9 bis Birmensdorf SBB und mit PTT-Bus eine Station in Richtung Zürich bis Birmensdorf Sternen/WSL.

**Course Details**

**Number** 551-0359-00L  
**Title** Plant Biochemistry  
**ECTS** 6  
**Hours** 7G  
**Lecturers** S. C. Zeeman, O. Kötzing

**Abstract**
In this block course, students actively participate in ongoing research projects on plant metabolism and are tutored individually by doctoral students and postdocs. In a lecture series, the theoretical background for the projects and their interrelationship is provided, and in a seminar series, students will present their projects as well as discuss topical recent publications.

**Objective**
In this block course, students actively participate in ongoing research projects on plant metabolism and are tutored individually by doctoral students and postdocs.

**Content**
Participation in the following research projects will be possible: Photosynthetic metabolism; how is photo-assimilated carbon allocated to sustain plant growth? Chloroplast biology; how is chloroplast function integrated with that to the whole cell? Starch biosynthesis and degradation; how are complex, semi-crystalline starch granules made from simple sugars, and once made, how are they degraded again to release the stored carbohydrate? Regulation of metabolism through protein-protein interaction; how and why do proteins involved in starch metabolism interact with each other to form multi-subunit enzymes and multi-enzyme complexes? Sugar sensing; How does a plant know how much sugar it has, and how does this influence development.

**Lecture notes**
No script

**Literature**

Lists of individual reading assignments will be handed out.

**Number** 551-1513-00L  
**Title** Cancer Cell Signaling: Mechanisms, Targets and Therapeutic Approaches  
**ECTS** 6  
**Hours** 7G  
**Lecturers** W. Krek, W. Kovacs

**Abstract**
This course will consider the pathogenetic landscape of cancer, explore how abnormalities of cellular information management cause cancer and demonstrate how the integrated application of modern omics technologies, mouse cancer models and human pathology provides a foundation for developing individualized cancer therapeutics. The course combines practical work with discussions and presentations.

**Objective**
Insights into and overview about the genetic alterations that underlie different cancer types, the complex cancer cell circuitries governing tumor development, modern approaches used in contemporary basic and translational cancer research and sophisticated strategies to control individual cancers and combat drug resistance.

**Lecture notes**
None

**Literature**

Will be provided for each of the projects at the beginning of the course.

**Number** 551-1147-00L  
**Title** Bioactive Natural Products from Bacteria  
**ECTS** 6  
**Hours** 7G  
**Lecturers** J. Piel

**Abstract**
Lab course. In small groups projects of relevance to current research questions in the field of bacterial natural product biosynthesis are addressed.

**Objective**
Introduction to relevant subjects of the secondary metabolism of bacteria. Training in practical work in a research laboratory. Scientific writing in form of a research report.

**Content**
Research project on bacteria that produce bioactive natural products (e.g., Streptomycetes, Cyanobacteria, uncultivated bacteria). The techniques used will depend on the project, e.g. PCR, cloning, natural product analysis, precursor feeding studies, enzyme expression and analysis.

**Lecture notes**
None

**Literature**

Will be provided for each of the projects at the beginning of the course.

**Number** 551-0351-00L  
**Title** Membrane Biology  
**ECTS** 6  
**Hours** 7G  
**Lecturers** V. Korkhov, M. Aebi, Y. Barral, B. Kornmann, U. Kutay, A. Rodriguez-Villalon, G. Schertler

**Abstract**
The course will introduce the students to the key concepts in membrane biology and will allow them to be involved in laboratory projects related to that broad field. The course will consist of lectures, literature discussions, and practical laboratory work in small groups. Results of the practical projects will be presented during the poster session at the end of the course.

**Objective**
The aim of the course is to expose the students to a wide range of modern research areas encompassed by the field of membrane biology.

**Content**
Students will be engaged in research projects aimed at understanding the biological membranes at the molecular, organellar and cellular levels. Students will design and perform experiments, evaluate experimental results, analyze the current scientific literature and understand the relevance of their work in the context of the current state of the membrane biology field.

**Lecture notes**
None

**Literature**
The recommended literature, including reviews and primary research articles, will be provided during the course.

**Prerequisites / notice**
The course will be taught in English. All general lectures will be held at ETH Hönggerberg; special lectures will be organized by individual participating groups. Students will be divided into small groups to carry out experiments at ETH or at the Paul Scherrer Institute. Travel to the Paul Scherrer Institute will be organized by car rental or public transportation.

**Block Courses in 3rd Quarter of the Semester**

**From 3.11.2015 13:00 hr to 25.11.2015, 17:00 hr**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>551-0355-00L</td>
<td>Phytopathology</td>
<td>W</td>
<td>6</td>
<td>7</td>
<td>M. Maurhofer Brinolf, B. McDonald</td>
</tr>
</tbody>
</table>

**Abstract**
Fundamentals (theoretical and practical) in phytopathology, e.g. interaction between plants and plant-pathogenic microorganisms, morphology and lifecycle of plant-pathogenic fungi, evolution of plant-pathogenic fungi, biological control of plant diseases

**Objective**
Insight into ongoing research projects
During the block course in the fall semester, we will carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. The class with its very dense program consists of the practical course itself and an integrated series of seminar/lecture sessions.

Handouts were provided at the start of the course and a script will be distributed to the participants on the first day of the course. All technologies used for the experiments will be explained to the students in theory and in practice with the goal that they will be able to independently apply them for the course project and in future research endeavors. After the course, an individual report about the results obtained has to be prepared.

Students will learn to design, carry out and assess experiments using current biochemical and cell biological strategies to analyze cellular functions. The course consists of practical projects in small groups, lectures, and literature discussions. The course concludes with the presentation of results at a poster session.

Further literature will be indicated in the distributed script.

This laboratory course will involve experiments that require a tight schedule and (sometimes) long (!) working days. The maximum number of participants for the laboratory class is limited, but surplus applicants may contact P. Kast directly to have their names added to a waiting list. A valid registration is considered a commitment for attendance of the entire course, as involved material orders and experimental preparations are necessary and, once the class has started, the flow of the experiments must not be interrupted by individual absences. In case of an emergency, please immediately notify P. Kast. For more information, see also

http://www.protein.ethz.ch/kast/praktikum.html

The students will obtain an overview about the current topics of research in insulin signaling and how it impacts on growth, metabolism and cell differentiation. They will learn to design experiments and use techniques necessary to analyze different aspects of insulin signaling, including physiological actions in whole animals as well as in tissue culture. Through lectures and literature seminars, they will learn about the open questions of insulin signaling research and discuss approaches to address these questions experimentally.

In practical lab projects the students will perform physiological in vivo studies as well as biochemical experiments. Finally, they will learn how to present and discuss their data. Student assessment is a graded semester performance based on individual performance in the laboratory, a written exam and the lab data presentation.

### 529-0739-01L Biological Chemistry B: New Enzymes from Directed Evolution Experiments

**Abstract**
During the block course in the fall semester, we will carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. By working in parallel, teams of 2 participants each will generate a variety of different variants of a chorismate mutase. Individual enzyme catalysts will be purified and subsequently characterized using several different spectroscopic methods. The detailed chemical-physical analyses include determination of the enzymes’ kinetic parameters, their molecular mass, and the integrity of the protein structure. The results obtained from the individual evolution experiments will be compared and discussed at the end of the class in a final seminar. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst. The detailed chemical-physical analyses include determination of the enzymes’ kinetic parameters, their molecular mass, and the integrity of the protein structure. The results obtained from the individual evolution experiments will be compared and discussed at the end of the class in a final seminar. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst.

**Objective**
All technologies used for the experiments will be explained to the students in theory and in practice with the goal that they will be able to independently apply them for the course project and in future research endeavors. After the course, an individual report about the results obtained has to be prepared.

**Content**
The class deals with a specifically designed and genuine research project. We intend to carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. By working in parallel, teams of 2 participants each will generate a variety of different variants of a chorismate mutase. Individual enzyme catalysts will be purified and subsequently characterized using several different spectroscopic methods. The detailed chemical-physical analyses include determination of the enzymes’ kinetic parameters, their molecular mass, and the integrity of the protein structure. The results obtained from the individual evolution experiments will be compared and discussed at the end of the class in a final seminar. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst.

**Lecture notes**
A script will be distributed to the participants on the first day of the course.

**Literature**
General literature to “Directed Evolution” and chorismate mutases, e.g.:


Further literature will be indicated in the distributed script.

### 551-0336-00L Methods in Cellular Biochemistry

**Abstract**
Students will learn about biochemical approaches to analyze cellular functions. The course consists of practical projects in small groups, lectures and literature discussions. The course concludes with the presentation of results at a poster session.

**Objective**
Students will learn to design, carry out and assess experiments using current biochemical and cell biological strategies to analyze cellular functions in a wide range of model systems. In particular they will learn novel imaging techniques along with biochemical approaches to understand fundamental cellular pathways. Furthermore, they will learn to assess strengths and limitations of the different approaches and be able to discuss their validity for the analysis of cellular functions.

**Literature**
Documentation and recommended literature (review articles and selected primary literature) will be provided during the course.

**Prerequisites / notice**
This course will be taught in English.

### 551-1515-00L Insulin Signaling

**Abstract**
Introduction to the physiological and biochemical action of insulin signaling and its role in the fasted/feeding response and in obesity and diabetes.

**Objective**
The students will obtain an overview about the current topics of research in insulin signaling and how it impacts on growth, metabolism and cell differentiation. They will learn to design experiments and use techniques necessary to analyze different aspects of insulin signaling, including physiological actions in whole animals as well as in tissue culture. Through lectures and literature seminars, they will learn about the open questions of insulin signaling research and discuss approaches to address these questions experimentally.

**Prerequisites / notice**
This course will be taught in English.

### 752-4020-00L Experimental Food Microbiology for Biologists

**Abstract**
Teaching of basic experimental knowledge for detection and identification of microorganisms in food. Practical experiments were accompanied by theoretical introductions. Students become acquainted with classical and state-of-the-art molecular techniques for the rapid detection of foodborne pathogens and experiments in dependence on current research topics of the Laboratory of Food Microbiology.

**Objective**
Introduction of methods and techniques of food microbiology

**Content**
Teaching of basic experimental knowledge for detection and identification of foodborne pathogens by applying state-of-the-art techniques as well as modern molecular techniques for the rapid identification of relevant foodborne pathogens.

**Lecture notes**
Handouts were provided at the start of the course

**Literature**
- Krämer: “Lebensmittel-Mikrobiologie” (Ulmer; UTB)
- Süssmuth et al.: “Mikrobiologisch-Biochemisches Praktikum” (Thieme)
**551-0363-00L**  
**Complex Carbohydrates - the Fourth Pillar of Life**  
*W* 6 credits 7G  R. Gauss  

**Number of participants limited to minimum 2 and maximum 6.**

**Abstract**  
In vitro & in vivo experiments will introduce current research on the biosynthesis, structure & function of protein-bound glycans in different pro- and eukaryotic microorganisms.

**Objective**  
Participants are familiar with the biosynthesis, structure and function of N-glycans in microorganisms and with the methods for their analysis.

**Content**  
- Topics: biosynthesis of asparagine-linked glycans in pro- and eukaryotes; structure of glycans in different organisms; methods to analyse the structure of glycans; function of glycans in protein quality control  
- Introductory lectures  
- Seminar with presentation and discussion of recent publications  
- Experiments that exemplify the current research done in the group

**551-0117-00L**  
**Plant Volatiles in Plant Insect Interactions**  
*W* 6 credits 7G  A. L. Clavijo McCormick, S. Halloran, K. Mauck

**Number of participants limited to 16.**

**Abstract**  
During the course students will become familiar with methods for the collection and analysis of plant-derived volatile organic compounds and explore the role of these compounds in mediating plant-insect interactions.

**Objective**  
The course will cover six main topics that will be connected throughout the experimental phase:
1. Plant volatile biosynthesis and classification  
2. Insect olfactory physiology  
3. Volatile-mediated plant-herbivore interactions  
4. Volatile-mediated multitrophic interactions  
5. Manipulation of plant volatile emission by vector-borne disease agents  
6. Methods for volatile collection and analysis  
The lab practical will be performed in a system consisting of the cabbage butterfly Pieris brassicae, its host plant Brassica oleracea (Brussels sprouts), and the parasitoid wasp Cotesia glomerata (natural enemy of P. brassicae).

**Student**  Students will collect volatiles from herbivore-damaged and undamaged plants and learn how to identify and quantify these compounds through gas chromatography coupled with mass spectrometry and flame ionization detection (GG-MS-FID). Afterwards, they will be able to compare volatile emissions from herbivore-damaged and undamaged plants and identify important volatile compounds associated with herbivory. Finally, students will evaluate the effect of herbivore-induced volatile compounds on the behavior of the herbivore (P. brassicae) and its natural enemy (C. glomerata), using different behavioral assays, including Y-tube olfactometers and wind tunnels.

**Lecture notes**  
No script

**Literature**  
The recommended literature, including reviews and primary research articles, will be provided during the course.

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### Block Courses in 4th Quarter of the Semester

**From 26.11.2015, 08:00 hr to 18.12.2015, 17:00 hr**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-0361-00L</td>
<td>Biology of Bryophytes and Ferns</td>
<td>W</td>
<td>6</td>
<td>7</td>
<td>R. Holderegger, A. L. Bergamini</td>
</tr>
</tbody>
</table>

**Abstract**  
Bryophytes: Basic knowledge on the morphology, ecology, biogeography and endangerment of bryophytes; knowledge of common species; skills in the determination of bryophytes; field trip.  
Ferns: basic knowledge on the life cycle, evolution and ecology of ferns; identification of Swiss ferns; field trips.

**Objective**  
Bryophytes: Basic knowledge on the morphology, ecology, biogeography and endangerment of bryophytes; knowledge of common species; skills in the determination of bryophytes.  
Ferns: basic knowledge on the life cycle, evolution and ecology of ferns; identification of Swiss ferns.

**Content**  
Bryophytes: Systematics and morphology of hornworts, liverworts and mosses and special themes such as ecology, biogeography, diversity and endangerment of bryophytes; one full-day field trip.  
Ferns: Life cycle; evolutionary groups of ferns and fern allies; breeding systems, micro- and macroevolution; ecology; full-day and half-day field trips.

**Lecture notes**  
Hand-outs are available.

**Literature**  

**Prerequisites / notice**  
Students have to present a poster on a special theme.

Grade according to poster presentation and contributions during the course.

Requirements: First and second year courses in Botany and Evolution.

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**551-1309-00L**  
**RNA-Biology**  
*W* 6 credits 7G  C. Claudio, F. Allain, J. Hall, H. L. Lightfoot, B. Mateescu, O. Voinnet, K. Weis, A. Wutz

**Number of participants limited to 24.**

**Abstract**  
Introduction to the diversity of current RNA-research at all levels from structural biology to systems biology using mainly model systems like S. cerevisiae (yeast), mammalian cells.

**Objective**  
The students will obtain an overview about the diversity of current RNA-research. They will learn to design experiments and use techniques necessary to analyze different aspects of RNA biology. Through lectures and literature seminars, they will learn about the burning questions of RNA research and discuss approaches to address these questions experimentally. In practical lab projects the students will work in one of the participating laboratories. Finally, they will learn how to present and discuss their data in an appropriate manner. Student assessment is a graded semester performance based on individual performance in the laboratory, the written exam and the poster presentation.

**Literature**  
Documentation and recommended literature will be provided at the beginning and during the course.

**Prerequisites / notice**  
The course will be taught in English.

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**551-1511-00L**  
**Parallels Between Tissue Repair and Cancer**  
*W* 6 credits 7G  S. Werner, U. Auf dem Keller, M. Schäfer

**Number of participants limited to 15.**

**Abstract**  
This course aims at the understanding of the cellular and molecular mechanisms underlying tissue repair processes in response to different insults. The focus will be on repair of the skin and the liver. In addition, we will highlight the parallels and differences between tissue repair and cancer.

**Objective**  
To learn the cellular and molecular principles underlying tissue repair processes, in particular in the skin and in the liver, and the parallels and differences to cancer. To learn modern technologies in Molecular and Cellular Biology as well as Histology and to use these technologies to study questions related to mechanisms underlying tissue repair and cancer.

---

Content

This course aims at the understanding of the cellular and molecular mechanisms underlying tissue repair processes in response to different insults. The focus will be on repair of the skin and the liver. In addition, we will highlight the parallels and differences between tissue repair and cancer. Experimental approaches include biochemical studies, molecular and cellular studies using cultured cell lines and primary cultures, as well as analysis of murine and human tissues.

The course combines practical work with lectures, discussions, project preparations and presentations. Siehe Lehrmaterialien.

Lecture notes

551-0371-00L Growth Control: Insights from Yeast and Flies

Number of participants limited to 8.

Abstract

All organisms have to control their growth in accordance with environmental conditions. This course focuses on the analysis of growth regulation in the model organisms yeast and Drosophila. The participants will perform experiments in small teams to study insulin/TOR signaling as a key regulator of cellular growth. A particular focus will be the discussion of current research.

Objective

The aims of the block course are that students

(I) understand the function and evolution of insulin/TOR signaling

(II) learn how genetic approaches in different organisms contribute to the understanding of human diseases such as cancer

(III) will get familiarized with reading and discussing research articles

(IV) get a first exposure to current research.

Lecture notes

Lecturers

H. Stocker, R. C. Dechant, E. Halen, M. Peter

Literature

Original research articles will be discussed during the course.

551-1403-00L Imaging Bacterial Cells in a Native State by Electron Cryotomography

Number of participants limited to 3.

Abstract

The goal is to acquire the techniques to image bacteria by electron cryotomography, resolving their structure in a native state, in 3D, and to macromolecular resolution. In a small group, students will perform wet lab experiments, data collection with stat-of-the-art equipment, data processing and analyses. The key method and its application in bacterial cell biology will be introduced by lectures.

Objective

Students will acquire the skills to cultivate bacteria, plunge-freeze samples for cryotomography, collect data using an electron cryomicroscope, process raw data, analyze tomograms, perform subtomogram averaging, model structures of interest, and generate movies for visualization.

https://www.mol.biol.ethz.ch/groups/pilhofer_group/

Block Courses in the 1st Half of the Semester

From 15.9.2015, 13:00 hr to 30.10.2015, 17:00 Uhr.

Number

Title

Type

ECTS

Hours

Lecturers

701-2437-01L Limnoecology (incl. two Practical Courses)

W

12 credits

10G+4P

J. Jokela, P. Spaak, F. Altermatt, T. Gonser, K. J. Räsänen, C. T. Robinson

Abstract

This course combines Limnology (the study of inland waters in its broad sense) with Ecological and Evolutionary concepts. It deals with rivers, groundwater, wetlands and lakes.

This course contains a lecture part, an experimental part, two determination courses (aquatic invertebrates and algae) as well as excursions.

Objective

During this course you will get an overview of the world's typical continental aquatic ecosystems. After this course you will be able to understand how aquatic organisms have adapted to their habitat, and how the interactions (e.g. food web) between organisms work. During the experimental part of this course you will learn the principles of doing research to observe interrelations in aquatic ecosystems. You will measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge. After this course you will know the most important aquatic species groups (macroinvertebrates, microinvertebrates and cryptogames) in Switzerland and the most important identification traits.

Content

The course contains a lecture part, an experimental part, two determination courses (aquatic invertebrates and algae) and field excursions.

Lecture:

The lecture part covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwaters. Applied case studies and experiments testing ecological and evolutionary processes in freshwaters.

Practical part:

The practical part includes an Excursion to the river Sense (Saturday 26th of September 2015):

On this excursion you will get to know and experience a natural river system. Further you will conduct in a team your own field research project.

Further the practical part contains two excursions to a lake (Greifensee) and a river (Töss). Additional you will perform in small groups an independent experiment in a research group at Eawag.

The taxonomic part will cover macroinvertebrates (e.g. Crustacean, aquatic insects), microinvertebrates and algae. The goal is to get to know the most common aquatic taxa in Switzerland, to identify them with commonly used identification literature, and to get an idea how these organisms are used in research and practice. (language: German, translation of the most important things during the course possible)

Lecture notes

Prerequisites / notice

The maximal participating number of biology students is 14. The course includes a mandatory field trip to the Sense River floodplain. It will take place Saturday 26th of September.

Block Courses during Semester Break

Number

Title

Type

ECTS

Hours

Lecturers

551-1143-00L Analysis of Human T and B Cell Responses to Infectious Agents

W

6 credits

7G

A. Lanzavecchia

Number of participants limited to 8.

Abstract

Students actively participate in ongoing research projects on the analysis of human T and B cell response to pathogens and vaccines. They will be tutored in small groups by doctoral students and postdocs. In a lecture series, the theoretical background for the projects will be provided and the students will have the opportunity to present their projects and discuss recent publications.

Objective

To learn current methodologies in human immunology through experimental work in the lab. To learn current concepts through lectures and discussion of original papers. Requirement for obtaining the credit points: oral presentation of the research project in a ppt format.
Abstract
Students will carry out defined research projects related to the current research topics of the groups of Prof. Glockshuber and Prof. Weber-Ban. The topics include mechanistic studies on the assembly of adhesive pili from pathogenic bacteria, disulfide bond formation in the bacterial periplasm, ATP-dependent chaperone-protease complexes and formation of amyloid deposits in Alzheimer's disease.

Objective
The course should enable the students to understand and apply biophysical methods, in particular kinetic and spectroscopic methods, to unravel the mechanism of complex reactions of biological macromolecules and assemblies in a quantitative manner.

Content
The students will be tutored in their experimental work by doctoral or postdoctoral students from the Glockshuber or Weber-Ban group. In addition, the course includes specific lectures that provide the theoretical background for the experimental work, as well as exercises on the numeric evaluation of biophysical data, and literature work.

Participation in one of the following projects will be possible:

Projects of the Glockshuber group:
- Purification, biophysical characterization and structure determination of enzymes required for disulfide bond formation in the periplasm of Gram-negative bacteria.
- Identification of intermediates in the aggregation of the human Abeta peptide

Experimental work on these projects involves
- Molecular cloning, recombinant protein production in E. coli and protein purification
- Protein crystallization
- Thermodynamic and kinetic characterization of conformational changes in proteins and protein-ligand interactions by fluorescence and circular dichroism spectroscopy
- Analysis of rapid reactions by stopped-flow fluorescence
- Negative-stain electron microscopy
- Light scattering

Projects of the Weber-Ban group:
- Generation and purification of site-directed variants of the E. coli ClpA/P protease and chaperone-proteasome complexes from other organisms, their biophysical characterization, including rapid kinetics by stopped-flow methods, ATPase activity measurements, negative-stain electron microscopy and light scattering

Lecture notes
No script

Literature
Literature related to the individual projects will be provided on the first day of the course.

Prerequisites / notice
Attendance of the concept course "Biomolecular Structure and Mechanism I: Protein Structure and Function" (551-0307-00L) in the autumn semester is highly recommended for acquiring the theoretical background to this block course.
<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
**Biology Teaching Diploma**

The programme "Teaching Diploma, Two Subjects in One-Step Procedure" will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

### Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects ■ W</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td></td>
<td>- Getting to know intelligence tests</td>
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<td></td>
<td>- Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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<td>Number of participants limited to 20.</td>
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<td>The successful completion of both course no. 851-0240-00L &quot;Menschliches Lernen (EW 1)&quot; and course no. 851-0239-01L &quot;Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)&quot; is a necessary prerequisite for this course.</td>
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<td><strong>Abstract</strong></td>
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<td>In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researchers, and in self-directed research projects.</td>
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<td>The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)</td>
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<td></td>
<td><strong>Learning goals include:</strong></td>
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<td>- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.</td>
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<td>- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.</td>
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<td></td>
<td>- Participants can design and conduct a study that is relevant for answering their research question.</td>
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<td></td>
<td>- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.</td>
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</table>
### Subject Didactics in Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0961-00L</td>
<td>Mentored Work Subject Didactics Biology A</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>J. Egli</td>
</tr>
<tr>
<td></td>
<td>Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.</td>
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<tr>
<td>Abstract</td>
<td>In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.</td>
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<tr>
<td>Objective</td>
<td>The objective is for the students:</td>
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<tr>
<td></td>
<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
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<td></td>
<td>- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.</td>
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<tr>
<td>Content</td>
<td>Themenwahl nach Vereinbarung.</td>
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<tr>
<td>Lecture notes</td>
<td>Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.</td>
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<tr>
<td>Literature</td>
<td>Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.</td>
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</table>

Die Arbeit sollte vor Beginn des Unterrichtspraktikums abgeschlossen werden.

Allfällige fachwissenschaftliche Auflagen müssen alle erfüllt sein, bevor mit der Mentorierten Arbeit begonnen werden kann.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-0962-00L</td>
<td>Mentored Work Subject Didactics Biology B</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>J. Egli</td>
</tr>
<tr>
<td></td>
<td>Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject and for students upgrading TC to Teaching Diploma. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.</td>
<td></td>
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<tr>
<td>Abstract</td>
<td>In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.</td>
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<td>The objective is for the students:</td>
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<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
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<td>- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.</td>
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<tr>
<td>Content</td>
<td>Thematische Schwerpunkte</td>
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<tr>
<td>Lecture notes</td>
<td>Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.</td>
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<td>Literature</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.</td>
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</tbody>
</table>

Die Arbeit sollte vor Beginn des Unterrichtspraktikums abgeschlossen werden.

Allfällige fachwissenschaftliche Auflagen müssen alle erfüllt sein, bevor mit der Mentorierten Arbeit begonnen werden kann.

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0971-00L</td>
<td>Subject Didactics Biology I</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>P. Faller</td>
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<tr>
<td></td>
<td>Simultaneous enrolment in Introductory Internship Biology</td>
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<td></td>
<td>- course 551-0968-00L - is compulsory.</td>
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<tr>
<td>Abstract</td>
<td>- Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics.</td>
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<td>- Application of teaching methods and techniques from educational science in biology classes.</td>
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<td>- Planning and preparation of lessons.</td>
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<td>Objective</td>
<td>- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the school-leaving examination (Matura), the framework curriculum and the conditions and objectives specified by their school.</td>
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<td>- They are in a position to select learning objectives and formulate these on the basis of the target level model. They can plan and prepare lessons and can also develop appropriate learning assignments.</td>
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<td>- Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements.</td>
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<td>- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.</td>
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<td>- They can select appropriate media for their work (e.g. school books) and use these. They can employ appropriate experiments.</td>
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<td>- The students can use different forms of examination for monitoring performance.</td>
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<td></td>
<td>- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.</td>
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### Professional Training

**Important:** You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0968-00L</td>
<td>Introductory Internship Biology ■ Simultaneous enrolment in Biology Didactics I - course 551-0871-00L - is compulsory.</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>P. Faller</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.</td>
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<td>Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.</td>
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<td>Content</td>
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<td></td>
<td>Literature</td>
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<td></td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
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<tr>
<td>551-0966-00L</td>
<td>Teaching Internship Biology ■ Teaching Internship Biology for Teaching Diploma Biology as Major Subject.</td>
<td>O</td>
<td>8</td>
<td>17P</td>
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<td>Abstract</td>
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<td>The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.</td>
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<td>Objective</td>
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<td></td>
<td>- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.</td>
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<td>- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.</td>
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<td>- They acquire the skills of the teaching trade.</td>
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<td>- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.</td>
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<td>- They learn to assess pupils’ work.</td>
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<td>- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.</td>
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<td>Literature</td>
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<td></td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
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<tr>
<td>551-0967-00L</td>
<td>Teaching Internship Biology ■ Teaching Internship for students upgrading TC to Teaching Diploma.</td>
<td>W</td>
<td>4</td>
<td>9P</td>
<td>P. Faller</td>
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<td>Abstract</td>
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<td>This is a supplement to the Teaching Internship required to obtain in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.</td>
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<td>Students are able to assess in their subject the importance of teaching topics from different angles. They learn and master the teaching trade. They can structure a given lesson topic for a group of learners technically and didactically correctly and they can transfer it into an appropriate learning environment. They manage to find the balance between instruction and openness, so that the learners have both, the necessary freedom and sufficient orientation to acquire actively and a effectively adaptive (expert) knowledge.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Literature</td>
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<td></td>
<td>Findet in der Regel am Schluss der Ausbildung, vor Ablegung der Prüfungslektionen statt.</td>
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<tr>
<td>551-0969-01L</td>
<td>Examination Lesson I Biology ■ Simultaneous enrolment in “Examination Lesson II Biology” (551-0969-02L) is compulsory.</td>
<td>O</td>
<td>1</td>
<td>2P</td>
<td>P. Faller</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>On the basis of a specified topic, the candidate shows that they are in a position to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.</td>
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</tbody>
</table>
E. Hafen

The students are informed about the examination theme in general 10 days before the examination date. They receive information about the examination theme from the responsible teacher. After successfully completing the module, students should be able to:

- to analyze the tuition given with regard to its strengths and weaknesses, and outline improvements.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.

P. Faller

Professional Exercises in Biology

Students conduct a series of "classical" biological school experiments and therefore gain practice and experience in this area. They are able to develop suitable protocols for different subject areas of school biology. Working out how to didactically embed and further developing suitable protocols for different subject areas of school biology. Working out how to didactically embed the experiments in lessons. Students can perform, off the cuff, 12 school experiments, which they have tested themselves, from the different subject areas, and conduct these correctly in technical terms. They can incorporate these experiments in their tuition in a didactically meaningful manner. Comments: By contrast to the Subject Specialisation 1 and 2 course units, these are "basic tests" and do not involve implementation of current research topics. The students' compilations are available in a data archive. Content


M. Zwicky

Specialized Biology Course with an Educational Focus: Teaching Diploma

Specialised Courses in the Respective Subject with an Educational Focus in Biology for Teaching Diploma. After successfully completing the module, students should be in a position:

- to call up more in-depth specialist knowledge of biology, covering a wide range of topics, and to impart this to others.
- to explain biological concepts and principles, as well as the way they fit together.
- to analyse controversial topics and to give factual explanations for these.
- to conduct more in-depth work on a research topic and to compile a tuition unit based on this topic.
- to prepare tuition units involving complex learning matter at a high specialist level which are suitably tailored to the recipients, and to teach these in a manner conducive to learning.

Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module comprises the parts:

1) Lecture (Tues. 08.00-09.45 hrs)
2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4) Semester thesis in a research group (7 weeks)

Literature
Literatur und Literaturhinweise werden online mit Hilfe der e-learning Platform OLAT abgegeben.
This Course lasts for two semesters. It can be started in autumn or in spring. Booking is only required once.

Performance Assessment:
Performance is assessed during the course of the entire modul, with a final test. Active participation in the colloquia and group seminars is required. The thesis report and an oral presentation have to be completed.

The Specialized Biology Course with an Educational Focus (12 CP) can be acknowledged, in agreement with the advisor of the respective elective major, as one of the two obligatory research projects (each 15 CP). In such a case, additional 3 CP must be obtained in another course.

In case of overbooking of the course, students enrolled in the Teaching Diploma in Biology will have priority for registration.

The course is organized jointly with the University of Zurich (Fachbereich Biologie) and is held at the Life Science Zurich Learning Center of the ETH Zurich and the University of Zurich.

**551-0963-02L**  
Specialized Biology Course with an Educational Focus II: Teaching Diploma  
Specialised Courses in the Respective Subject with an Educational Focus in Biology ONLY for students upgrading TC to Teaching Diploma.

Abstract  
Specialized aspects of biology are dealt with under the viewpoint of their presentation, their historical development, their significance for the field, the individual and society.

Objective  
The goal is to promote the ability to understand biological concepts, principles and their interrelationships and to communicate specialist knowledge to various groups of recipients in an understandable manner.

Content  
Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module:

1) Lecture (Tues. 08.00-09.45 hrs)
2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4) Semester thesis in a research group (3.5 weeks)

Lecture notes  
None.

Literature  
Specific references will be made available for the individual projects.

Prerequisites / notice  
The program of this course represents one half (6 CP) of that of the Specialized Biology Course with an Educational Focus (551-0963-00, 12 CP).

### Compulsory Elective Courses

Further course offerings from the category Educational Science are listed under “Programme: Educational Science for Teaching Diploma and TC”.

Teaching Diploma in 2 Subjects in One-Step Procedure:

a) courses from the category Compulsory Elective Courses of the Minor Subject may also be selected;

b) courses from the category Specialized Courses in the Respective Subject, either of the Major or the Minor Subject, may also be selected.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0180-00L</td>
<td><strong>Research Ethics</strong></td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>G. Achermann</td>
</tr>
</tbody>
</table>

Abstract  
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective  
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.
Environmental Governance

W 3 credits  2G  E. Lieberherr, G. de Buren

Abstract
The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

Objective
To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science.

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

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

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

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

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

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

Literature
We will mostly work with readings from the following books:

Sustainability Assessment

W 3 credits  2G  P. Krütli, C. E. Pohl

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

Objective
The course is seminar-like, interactive.

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

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

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

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

Learning and Teaching Biology

W 6 credits  7G  E. Hafen, M. Klymkowsky

Abstract
This course represents an introduction to recent research into student learning on the conceptual foundations of modern biology, together with pedagogical methods associated with effective instruction and its validation. Students will be involved in active research into conceptual and practical issues involved in biology education and methods to discover student preconceptions.

Objective
Provides an overview on student's learning and shows ways to make the classroom experience more engaging and effective for students. Students will learn to produce a research-based paper on a project they work on during the course.
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird ECTS-Themenwahl nach Vereinbarung.

The course is not taught by a particular book, but recommended literature (review articles and selected primary literature) will be provided.

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Mentored Work Subject Didactics in Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0971-00L</td>
<td>Subject Didactics Biology I ■</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Faller</td>
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<tr>
<td></td>
<td>Simultaneous enrolment in Introductory Internship Biology - course 551-0968-00L - is compulsory.</td>
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<tr>
<td>Abstract</td>
<td>- Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics. - Application of teaching methods and techniques from educational science in biology classes. - Planning and preparation of lessons. - Assessing learning performance (forms of examination/assessment).</td>
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<tr>
<td>Objective</td>
<td>- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the school-leaving examination (Matura), the framework curriculum and the conditions and objectives specified by their school. - They are in a position to select learning objectives and formulate these on the basis of the target level model. They can plan and prepare lessons and can also develop appropriate learning assignments. - Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements. - They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners. - They can select appropriate media for their work (e.g. school books) and use these. They can employ appropriate experiments. - The students can use different forms of examination for monitoring performance. - Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.</td>
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<tr>
<td>Lecture notes</td>
<td>Wird laufend in der Vorlesung abgegeben.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Studierende müssen LE zusammen mit dem Einführungspraktikum - LE 551-0968-00L - belegen.</td>
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551-0961-00L Mentored Work Subject Didactics Biology A ■ Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Themenwahl nach Vereinbarung. Reflexion über Themen aus allen biologiespezifischen Bereichen des Unterrichts.

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

Literature
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice
Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

Die Arbeit sollte vor Beginn des Unterrichts praktikums abgeschlossen werden.

Allfällige fachwissenschaftliche Auflagen müssen alle erfüllt sein, bevor mit der Mentorierten Arbeit begonnen werden kann.

551-0962-00L Mentored Work Subject Didactics Biology B ■ Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject and for students upgrading TC to Teaching Diploma. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Professional Training in Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0965-00L</td>
<td>Teaching Internship Including Examination Lessons</td>
<td>O</td>
<td>4</td>
<td>9P</td>
<td>P. Faller</td>
</tr>
<tr>
<td></td>
<td>Teaching Internship for TC and Teaching Diploma</td>
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<td>Repetition of the Teaching Internship is excluded even if</td>
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<tr>
<td></td>
<td>Examination Lessons are to be repeated</td>
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</table>

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

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

Course Units for Additional Admission Requirements

The courses below are only available for students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0980-00L</td>
<td>Anthropology (University of Zurich)</td>
<td>E-</td>
<td>3</td>
<td>6G</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO133</td>
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<td></td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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</table>

Abstract
Genetics, fossil remains, comparative anatomy and behavioral research prove the affiliation of humans to primates. This mammalian order represents variations of a single theme. The main adaptations and the critical steps of phylogeny are presented.

Objective
Upon successfully completing of the module the students can:
- interpret the main features of primates and especially of fossil hominids in the evolutionary and functional context;
- explain the genetic, phenetic and cultural diversity of modern human populations as the result of evolutionary processes;
- recognize similarities and differences in the behavior and the cognitive lines from humans and animals, in particular monkeys;
- explain why cultural evolution occurs only in humans;
- discuss the question "What are human beings?" from an evolutionary biological perspective.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-0151-00L</td>
<td>Anatomy I and Physiology I</td>
<td>E-</td>
<td>6</td>
<td>4V</td>
<td>M. Ristow, M. Flück, L. Stiomianka, C. Spengler, N. Wenderoth, D. P. Wolfer</td>
</tr>
</tbody>
</table>

Abstract
Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, the neuro-muscular system, the cardiovascular system and the respiratory system.

Objective
Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.
Content

Short overview of human anatomy, physiology and general pathology.

Anatomy and Physiology I (fall term):
Basics of cytology, histology, embryology, general pathology; nervous system, muscles, cardiovascular system, respiratory system

Anatomy and Physiology II (spring term):
digestive system, kidney and urinary tract, endocrine system, skin, thermoregulation, sensory organs, male and female reproductive system, pregnancy and child birth.

Lecture notes


Literature

Anatomie:

Schiebler TH, Korf H-W: Anatomie (10. vollständig überarbeitete Auflage)
Steinkopf / Springer, Heidelberg 2007

Martini FH, Timmons MJ, Tallitsch RB. Human Anatomy

Physiologie:


Prerequisites / notice

Voraussetzungen: 1. Jahr, naturwissenschaftlicher Teil

Biology Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>Example</th>
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<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
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Key for Hours

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<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
</tr>
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<td>colloquium</td>
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</table>

ECTS

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Students will be able to:

- Type

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-2413-00L</td>
<td>Evolutionary Genetics</td>
<td>O</td>
<td>6</td>
<td>4V</td>
<td>T. Städler, A. Widmer, P. C. Brummer, M. C. Fischer, A. Guggisberg</td>
</tr>
<tr>
<td>701-0323-00L</td>
<td>Plant Ecology</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>S. Güsewell, J. Levine</td>
</tr>
</tbody>
</table>

**Abstract**

The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

**Objective**

The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

**Content**

- Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.
- Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher's fundamental theorem.
- Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation.

**Prerequisites / Literature**

There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

**Lecture notes / notice**

Handouts and further reading will be available electronically at the beginning of the semester.

**LANGUAGE**

Lectures and handouts are normally in German, but we shall switch to English on request. Non-German-speaking students who intend to attend the course should contact S. Güsewell before the start of the semester to ask for the change in language.

**Compulsory Concept Courses**

**Elective Major Subject Areas**

**Elective Major: Ecology and Evolution**

**Elective Compulsory Master Courses**

**Number**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>751-4801-00L</td>
<td>System-Oriented Management of Herbivore Insects I</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>D. Mazzi</td>
</tr>
<tr>
<td>551-1701-00L</td>
<td>Research Seminar: Ecological Genetics</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>A. Widmer, S. Fior</td>
</tr>
</tbody>
</table>

**Abstract**

In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

**Objective**

It is our aim that participants gain insight into the current research topics and knowledge available in Ecological Genetics and learn to critically assess and appreciate scientific publications in this field.

**Literature**

None will be distributed.
Prerequisites / notice

Active participation in the discussions is a prerequisite for this course.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Hours</th>
<th>Instructor(s)</th>
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<tr>
<td>551-1703-00L</td>
<td>Ecology of Anthropogenic Habitats</td>
<td>W</td>
<td>2</td>
<td>1V</td>
<td>D. Ramseier</td>
</tr>
<tr>
<td>701-1441-00L</td>
<td>Alpine Ecology and Environments</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. Dietz, D. Ramseier</td>
</tr>
<tr>
<td>751-5121-00L</td>
<td>Insect Ecology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>S. Halloran, C. De Moraes, M. Mescher</td>
</tr>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>M. Dettling</td>
</tr>
</tbody>
</table>

Abstract

The focus will be on agro-ecology and ecology of urban habitats. Both experience frequent disturbances, specific chemical influences, and extreme climatic conditions. Additionally, in urban habitats edaphic conditions are difficult as well. Turnover of species diversity and composition are higher, both locally and temporary, compared to natural conditions at comparable sites.

Objective

Knowledge of agro-ecosystems and urban ecosystems; their origin, ecosystem services, mechanisms and importance for the maintenance of biodiversity.

Content

The online course ALPECOLe provides a global overview of the complex ecosystems of mountain regions, and of their great diversity of habitats and organisms. The course is strongly interdisciplinary and the various approaches are designed to help understand the past, present and future of mountain ecosystems.

Objective

Knowledge of alpine environments worldwide and their ecology

Content

The online course is subdivided into:
- 5 lessons on abiotic factors: geology, soils and their forming processes, climate, and disturbance factors
- 12 lessons on plants: diversity, patterns and processes, treelines, water & nutrients, carbon cycle, atmospheric influences, sexual and clonal reproduction, and one specific lesson on aquatic environments
- 5 lessons on animals: habitats and adaptations, origin of species, food ecology and impact of domestic livestock
- 3 lessons on landscape evolution: quaternary paleoenvironments, methods like radiocarbon dating, pollen records, dendrochronology, stable isotopes, and historical data
- 1 lesson on global change

Students can also follow a virtual walk through alpine areas where context-based information on alpine environments can be accessed. Moreover, all major alpine areas of the world can be selected on a map and then informative pictures of those landscapes and faunistic and floristic inhabitants will be shown.

Online exercises and tests allow to test the learned matter.

Additionally to the online lessons, three supplementary papers will be read and discussed during the tutorials.

Prerequisites / notice

Online course
Course language is English

Abstract

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

Objective

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

Lecture notes

Provided to students through ILIAS

Literature

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

Abstract

Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content


Lecture notes

see website

Literature


Abstract

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content

The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Lecture notes

A script will be available.

Literature

Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

### Prerequisites / notice

The course provides the ecological systems' knowledge needed to question applied solutions to current environmental issues. Our central aim is to balance participants' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.

At the end of the course...

...you know how to structure your inquiry and how to proceed the analysis when faced with a complex environmental issue. You can formulate the relevant questions, find answers (supported by discussions, input from the lecturers and the literature), and you are able to present your conclusions clearly and cautiously.

...you understand the complexity of interactions and structures in ecosystems. You know how ecosystem processes, functions and services interact and feed back across multiple spatio-temporal scales (in general, plus in depth case examples).

...you understand that biodiversity and the interaction between organisms are an integral part of ecosystems. You are aware that the link between biodiversity and process/function/service is rarely fully understood. You know how to honestly deal with this lack of understanding and can nevertheless find, critically analyse and communicate solutions.

...you understand the importance of ecosystem services for society.

...you have an overview of the methods of ecosystem research and have a deeper insight into some of them, e.g. ecosystem observation, manipulation and modelling.

...you have reflected on ecology as a young discipline at the heart of significant applied questions.

The course is structured around four larger topical areas: (1) Integrated Water Management -- Green infrastructure (land management options) as an alternative to engineered solutions (e.g. large reservoirs) in flood and drought management; (2) Fire dynamics, the water cycle and biodiversity -- The surprising dynamics of species life cycles and populations in arid landscapes; (3) Rewilding, e.g. reintroducing apex predators (e.g. wolves), or large ungulates (e.g. bisons) in protected areas -- A nature conservation trend with counterintuitive effects; (4) Coupling of aquatic and terrestrial systems: carbon, nitrogen and phosphorus transfers of global importance on landscape scale.

### Literature


Schulze et al. (2005) Plant Ecology; Springer.


Schulze et al. (2005) Plant Ecology; Springer.


Schulze et al. (2005) Plant Ecology; Springer.


### Prerequisites / notice

The course combines elements of a classic lecture, group discussions and problem based learning. It is helpful, but not essential to be familiar with the "seven stages" method (see e.g. course 701-0352-00L "Analysis and Assessment of Environmental Sustainability" by Christian Pohl et al.).

### Using R for Data Analysis and Graphics (Part I)

#### Abstract

The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

The students will be able to use the software R for simple data analysis.

Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.

Lecture notes


The course resources will be provided via the Moodle web learning platform

Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

### Prerequisites / notice

The course provides the second part an introduction to the statistical software R for scientists. Topics are data generation and selection, graphical functions, important statistical functions, types of objects, models, programming and writing functions.

Note: This part builds on "Using R... (Part I)", but can be taken independently if the basics of R are already known.

The students will be able to use the software R efficiently for data analysis.

#### Objective

The course provides the second part an introduction to the statistical software R for scientists. Topics are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

The students will be able to use the software R for simple data analysis.

Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.
Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1     No Lecture: First day of autumn semester

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


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

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

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

Week 8     Pathogen effects on food quality and safety.

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

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

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

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

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

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

The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145. Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org. An Introduction to R: http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_RHL.pdf

Basic knowledge of R equivalent to "Using R ... (part 1)" (= 401-6215-00L) is a prerequisite for this course.

The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.
Objective
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:
- models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- stochastic processes
Attendees will apply these concepts to a number of applications yielding biological insight into:
- epidemiology
- pathogen evolution
- macroevolution of species

Content
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes
Slides of the lecture will be available online.

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics.

701-1419-00L Analysis of Ecological Data W 2 credits 2G S. Güsewell

Abstract
This class provides students with an overview of techniques for data analysis used in modern ecological research, as well as practical experience in running these analyses with R and interpreting the results. Topics include linear models, generalized linear models, mixed models, model selection and randomization methods.

Objective
Students will be able to:
- describe the aims and principles of important techniques for the analysis of ecological data
- choose appropriate techniques for given problems and types of data
- evaluate assumptions and limitations
- implement the analyses in R
- represent the relevant results in graphs, tables and text
- interpret and evaluate the results in ecological terms

Content
- Linear models for experimental and observational studies
- Model selection
- Introduction to likelihood inference and Bayesian statistics
- Analysis of counts and proportions (generalised linear models)
- Models for non-linear relationships
- Grouping and correlation structures (mixed models)
- Randomisation methods

Lecture notes
Lecture notes and additional reading will be available electronically a few days before the course

Literature
Suggested books for additional reading (available electronically)

Prerequisites / notice
Time schedule
The course takes place over a period of nine days from Thursday 14.01 to Friday 22.01, with classes on 14, 15, 18, 19 and 20.01. and an exam on 22.01.

Prerequisites
- Basic statistical training (e.g. Mathematik IV in D-USYS): Data distributions, descriptive statistics, hypothesis testing, linear regression, analysis of variance
- Basic experience in data handling and data analysis in R

Individual preparation
Students without the required knowledge are asked to contact the lecturer before Christmas for support with individual preparation.

Elective Concept Courses

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<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

Abstract
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
Objectives

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content

Bioinformatics I will cover the following topics:

From genes to databases and information
BLAST searches
Prediction of gene function and regulation
RNA structure prediction
Gene expression analysis using microarrays
Protein sequence and structure databases
WWW for bioinformatics
Protein sequence comparisons
Proteomics and de novo protein sequencing
Protein structure prediction
Cellular and protein interaction networks
Molecular dynamics simulation

551-0313-00L Microbiology (Part I) W 3 credits 2V W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pillhofer

Abstract

Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective

This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content

Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes

Updated handouts will be provided during the class.

Literature

Current literature references will be provided during the lectures.

Prerequisites / notice

English

The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

551-0309-00L Concepts in Modern Genetics W 6 credits 4V Y. Barrat, D. Bopp, A. Hajnal, O. Voinnet

Abstract

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective

This course focuses on the concepts of classical and modern genetics and genomics.

Content

The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes

Scripts and additional material will be provided during the semester.

Prerequisites / notice

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UniZH Irchel.

Elective Major: Neurosciences

Compulsory Concept Courses

See D-BIOL Master Studies Guide

Elective Compulsory Concept Courses

See D-BIOL Master Studies Guide

Data: 06.12.2018 13:04 Autumn Semester 2015 Page 204 of 1432
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

The colloquium in Neuroinformatics is a series of lectures given by invited experts. The lecture topics reflect the current themes in computational neuroscience, covering a wide range of topics from the structure and function of neurons to computational models of neural computations and learning. The colloquium series will provide a platform for the exchange of ideas and stimulate interdisciplinary collaboration.

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Cells and organs of the immune system, B cells and antibodies, Generation of diversity, Th1 and Th2 cells, regulatory T cells, Allergies, Hypersensitivities, Vaccines, immune-therapeutic interventions.

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

**Elective Compulsory Master Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeffer</td>
</tr>
<tr>
<td>227-1043-00L</td>
<td>Neuroinformatics - Colloquia</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>S.C. Liu, R. Hahnloser, V. Mante, M. Pfeffer</td>
</tr>
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</table>

The colloquium in Neuroinformatics is a series of lectures given by invited experts. The lecture topics reflect the current themes in neurobiology and neuromorphic engineering that are relevant for our Institute.
The goal of these talks is to provide insight into recent research results. The talks are not meant for the general public, but really aimed at specialists in the field.

### 227-1047-00L

**Consciousness: From Philosophy to Neuroscience**  
W 3 credits 2V D. Kiper, A. Gamma  

**Objective**  
The course's goal is to give an overview of the contemporary state of consciousness research, with emphasis on the contributions brought by modern cognitive neuroscience. We aim to clarify concepts, explain their philosophical and scientific backgrounds, and to present experimental protocols that shed light on a variety of consciousness related issues.

**Content**  
The course includes discussions of scientific as well as philosophical articles. We review current schools of thought, models of consciousness, and proposals for the neural correlate of consciousness (NCC).

**Lecture notes**  
None

**Literature**  
None

**Prerequisites / notice**  
Since we are all experts on consciousness, we expect active participation and discussions!

---

**227-1051-00L**  
Introduction to Systems Neuroscience  
W 6 credits 2V+1U D. Kiper  

**Abstract**  
This seminar reviews the philosophical and phenomenological as well as the neurobiological aspects of consciousness. The subjective features of consciousness are explored, and modern research into its neural substrate, particularly in the visual domain, is explained. Emphasis is placed on students developing their own thinking through a discussion-centered course structure.

**Objective**  
The course's goal is to give an overview of the contemporary state of consciousness research, with emphasis on the contributions brought by modern cognitive neuroscience. We aim to clarify concepts, explain their philosophical and scientific backgrounds, and to present experimental protocols that shed light on a variety of consciousness related issues.

**Content**  
The course includes discussions of scientific as well as philosophical articles. We review current schools of thought, models of consciousness, and proposals for the neural correlate of consciousness (NCC).

**Lecture notes**  
None

**Literature**  
"Principles of Neural Science", Kandel, Schwartz, and Jessel

**Prerequisites / notice**  
We display articles pertaining to the issues we cover in the class on the course's webpage. Since we are all experts on consciousness, we expect active participation and discussions!

---

**227-1035-00L**  
Dynamical Systems in Biology  
W 6 credits 2V+1U R. Stoop  

**Abstract**  
This lecture uses the concepts from dynamical systems (Course: "Computable Chaos in Dynamical Systems") for the description of salient phenomena in complex examples from population dynamics, neuroinformatics and system biology. A particular focus is on the concept of limit cycle solutions and their coupling.

**Objective**  
Applying concepts from nonlinear dynamics to biological systems. Combining theoretical modeling with supporting computer simulations.

---

**376-1414-00L**  
Current Topics in Brain Research  
W 1 credit 1.5K M. E. Schwab, F. Helmchen, S. Jessberger, I. Mansuy, further lecturers  

**Abstract**  
Different national and international scientific guests are invited to present and discuss their actual scientific results.

**Objective**  
To exchange scientific knowledge and data and to promote communication and collaborations among researchers.

**Content**  
Different scientific guests working in the field of molecular cognition, neurochemistry, neurormorphology and neurophysiology present their latest scientific results.

**Lecture notes**  
no handout

**Literature**  
no literature

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**227-1045-00L**  
Readings in Neuroinformatics  
W 3 credits 1S G. Indiveri, M. Cook, D. Kiper  

**Abstract**  
Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. We will read both original papers and explore the conceptual links between them and discuss the 'sociology' of science, the pursuit of basic science questions over a century of research. It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote. Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else's digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and linked together by related findings from many different scientists, generate the current views of mechanism and structure of the nervous system. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. Each week the course members will be given original papers to read for homework, they will have to write a short abstract for each paper. We will then meet weekly with the course leader (KACM) and an assistant for an hour-or-so long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will in the form of a written exam in which the students will be given a paper and asked to write a short abstract of the contents.
Content

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research reading the original publications, instead of reading someone else's digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and by many different scientists, linked together to generate the current view of mechanism and structure. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. Each week the course members will be given between 2 and 4 papers to read for homework and we will then meet weekly for an hour long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will be done continuously as the individual students are asked to explain a figure, technique, or concept.

551-1145-00L Viral and non-Viral Vectors for Human Gene-Therapy - from Pathogens to Safe Medical Applications

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. 

UZH Module Code: BIO708

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

Objective

Knowledge of important viral and non-viral vector systems.

Knowledge of application in human diseases.

Knowledge of limiting factors.

636-0017-00L Molecular Evolution, Phylogenetics and Phylodynamics

Abstract

The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Objective

Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:

* models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics
* stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:

* epidemiology
* pathogen evolution
* macroevolution of species

Content

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the course, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes

Slides of the lecture will be available online.

Literature

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics.

551-1409-00L RNA Biology Lecture Series II: Non-coding RNAs: Biology and Therapeutics

Abstract

This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

Objective

The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

Content

Micro RNAs: computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; nucleic acid-based drugs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; tRNA biology.


Prerequisites / notice

Basic knowledge of cell and molecular biology.

Elective Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-0317-00L</td>
<td>Immunology I</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Oxenius, M. Kopf</td>
</tr>
</tbody>
</table>

Abstract

Introduction into structural and functional aspects of the immune system.

Objective

Basic knowledge of the mechanisms and the regulation of an immune response.
Introduction and historical background

- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"


Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

- Vaccines, immune-therapeutic interventions
- Hypersensitivities
- Allergies
- Th1 and Th2 cells, regulatory T cells
- Autoimmunity
- Cytotoxic T cells and NK cells
- Thymus and T cell selection
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Autoimmunity
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- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

551-0319-00L

Cellular Biochemistry (Part I)

- Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.
- Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

W 3 credits
2V
U. Kutay, C. M. Azzalin, B. Kornmann, M. Peter

551-0313-00L

Microbiology (Part I)

- Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

O 3 credits
2V
W. D. Hardt, L. Eberl, H. M. Fischer, J. Piel, M. Pilhofer

551-0317-00L

Immunology I

- Introduction into structural and functional aspects of the immune system.

O 3 credits
2V
A. Oxenius, M. Kopf

551-0319-00L

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551-0317-00L

Immunology I

- Introduction into structural and functional aspects of the immune system.

O 3 credits
2V
A. Oxenius, M. Kopf
Presentations will be made available after the seminars.

Lecturers

- T. J. Eber,
- W.

**Current Topics in Molecular and Cellular Neurobiology**

**Objective**

You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

**Content**

- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

**Notice**

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

**Prerequisites / Literature**

- Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

### Elective Compulsory Master Courses

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<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0223-00L</td>
<td>Immunology III</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Kopf, M. Bachmann, J. Kisielow, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spörri</td>
</tr>
<tr>
<td>551-0512-00L</td>
<td>Current Topics in Molecular and Cellular Neurobiology</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>U. Suter</td>
</tr>
<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, T. J. Erb, J. Piel</td>
</tr>
</tbody>
</table>

Content
Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaplerotic provocation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

Lecture notes
A script will be provided during the course.

551-1105-00L Glycobiology W 4 credits 2V M. Aebi, T. Henne
Abstract
Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

Objective
Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

Content
- Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminylglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

Literature
Introduction to Glycobiology; M.E.Taylor, K.Drickamer, Oxford University Press, 2003

Prerequisites / notice
The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1117-00L Cutting Edge Topics: Immunology and Infection Biology W 2 credits 1S A. Oxenius, B. Becher, C. Halin Winter, M. Kopf, S. R. Leibundgut, C. Münz, A. Trkola, M. van den Broek
Abstract
Weekly seminar about cutting edge topics in immunology and infection biology. Internationally renowned experts present their current research followed by an open discussion.

Objective
Weekly seminar about cutting edge topics in immunology and infection biology. Internationally renowned experts present their current research followed by an open discussion.

Content
- Immunology and infection biology.
- The specific topics are variable and depend each semester on the list of invited experts.

551-1153-00L Systems Biology of Metabolism W 4 credits 2V U. Sauer, N. Zamboni, M. Zampieri
Number of participants limited to 15.
Abstract
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content
- The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics.
- For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes
Handouts
Prerequisites / notice
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

551-1171-00L Immunology: from Milestones to Current Topics W 4 credits 2S B. Ludewig, M. Kopf, A. Oxenius, University lecturers
Number of participants limited to 15.
Abstract
Milestones in Immunology: on old concepts and modern experiments
Objective
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Content
- Milestones and current topics of innate immunity, antigen presentatino, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Lecture notes
Script and original publications will be supplied during the course.

Prerequisites / notice
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

551-1303-00L Current Research Topics in Cellular Biochemistry W 4 credits 2S V. Panse, C. M. Azzalin, V. Korkhov, R. Kroschewski, P. Picotti, A. E. Smith, F. van Drogen
Number of participants limited to 15.
Abstract
Introduction, presentation, evaluation, critical discussion and written analysis of recent scientific articles in the research area of cellular biochemistry.

Objective
The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.
### Content
The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

### Literature
The relevant references to primary literature and review articles will be provided during the course.

### Prerequisites / notice
The course will be taught in English.

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>636-0001-00L</td>
<td>Separations in Biotechnology and Bioprocess</td>
<td>W 6</td>
<td>3G</td>
<td>S. Panke</td>
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<tr>
<td><strong>Economy</strong></td>
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<tr>
<td><strong>Abstract</strong></td>
<td>Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select &amp; roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations &amp; judge on process economy.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Introduction membrane operations adsorption and chromatography crystallization overall process economics</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts during course</td>
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<tbody>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W 3</td>
<td>2V</td>
<td>M. Loessner, M. Schuppler</td>
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<tr>
<td><strong>Economy</strong></td>
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<tr>
<td><strong>Abstract</strong></td>
<td>The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Electronic copies of the presentation slides (PDF) will be made available for download to registered students.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Recommendations will be given in the first lecture</td>
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<td><strong>Prerequisites / notice</strong></td>
<td>Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), no break.</td>
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<tbody>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W 3</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
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<tr>
<td><strong>Economy</strong></td>
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<tr>
<td><strong>Abstract</strong></td>
<td>This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.</td>
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<tr>
<td><strong>Content</strong></td>
<td>This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:</td>
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<td></td>
<td>- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.</td>
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<td></td>
<td>- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.</td>
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<td>- Legal and Protection Issues Related Functional Foods</td>
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<td>- Industrial Biotechnology of Flavor and Taste Development</td>
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<td></td>
<td>- Safety of Food Starter Cultures and Probiotics</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>A list of references will be given at the beginning of the course for the different topics presented during this course.</td>
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<tbody>
<tr>
<td>751-4504-00L</td>
<td>Plant Pathology I</td>
<td>W 2</td>
<td>2G</td>
<td>F. Talas, B. McDonald, J. Palma Guerrero, A. Sanchez Vallet</td>
</tr>
<tr>
<td><strong>Economy</strong></td>
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<tr>
<td><strong>Abstract</strong></td>
<td>Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.</td>
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</table>
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

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


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

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

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

Week 8  Pathogen effects on food quality and safety.

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

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

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

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

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

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

Lecture notes

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1145-00L</td>
<td>Viral and non-Viral Vectors for Human Gene-Therapy - from Pathogens to Safe Medical Applications</td>
<td>2</td>
<td>University lecturers</td>
</tr>
<tr>
<td>636-0017-00L</td>
<td>Molecular Evolution, Phylogenetics and Phylodynamics</td>
<td>4</td>
<td>T. Stadler</td>
</tr>
</tbody>
</table>
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

### Elective Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>751-4805-00L</td>
<td>Recent Advances in Biocommunication</td>
<td>W</td>
<td>4G</td>
<td>C. De Moraes</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-4005-00L</td>
<td>Food Microbiology I</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Loessner</td>
</tr>
</tbody>
</table>

### Literature

- The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
  - * Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

### Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics.

### Abstract

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

### Objective

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

### Content

1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spillage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP’s of Food Microbiology
2. Overview of Microorganisms in Foods
   2.1. Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
   3. Microbial Spillage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

### Lecture notes

Electronic copies of the presentation slides (PDF) will be made available for download.

### Literature

Recommendations will be given in the first lecture.

### Introduction to Bioinformatics: Concepts and Applications

- W | 6 credits | 4G | W. Gruissem, K. Bärenfaller, A. Callisch, G. Captiani, J. Fütterer, M. Robinson, A. Wagner

### Abstract

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

### Objective

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.
Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

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<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Semester</th>
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<tbody>
<tr>
<td>701-2413-00L</td>
<td>Evolutionary Genetics</td>
<td>W</td>
<td>6</td>
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<tr>
<td></td>
<td>T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer, A. Guggisberg</td>
<td></td>
<td>4V</td>
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</table>

**Abstract**

The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

**Objective**

The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

**Content**

- Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.
- Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding; effects on fitness; Fisher's fundamental theorem.
- Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation

**Lecture notes**

Handouts

**Literature**


**Prerequisites / notice**

There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

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<th>Course Code</th>
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<th>Semester</th>
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<tr>
<td>551-0311-00L</td>
<td>Molecular Life of Plants</td>
<td>W</td>
<td>6</td>
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**Abstract**

The advanced course introduces students to plants through a concept-based discussion of developmental processes that integrates physiology and biochemistry with genetics, molecular biology, and cell biology. The course follows the life of the plant, starting with the seed, progressing through germination to the seedling and mature plant, and ending with reproduction and senescence.

**Objective**

The new course "Molecular Life of Plants" reflects the rapid advances that are occurring in the field of experimental plant biology as well as the changing interests of students being trained in this discipline. Contemporary plant biology courses emphasize a traditional approach to experimental plant biology by discussing discrete topics that are removed from the context of the plant life cycle. The course will take an integrative approach that focuses on developmental concepts. Whereas traditional plant physiology courses were based on research carried out on intact plants or plant organs and were often based on phenomenological observations, current research in plant biology emphasizes work at the cellular, subcellular and molecular levels.

The goal of "Molecular Life of Plants" is to train students in integrative approaches to understand the function of plants in a developmental context. While the course focuses on plants, the training integrative approaches will also be useful for other organisms.

**Content**

The course "Molecular Life of Plants" will cover the following topics in a developmental context:

- Plant genome organization
- Seed anatomy
- Food reserves and mobilization
- Seedling emergence
- Heterotrophic to autotrophic growth
- Chlorophyll biosynthesis, photoreceptors
- Integration of metabolism
- Hormones
- Cell cycle
- Cell differentiation and expansion
- Environmental interactions: abiotic, environmental interactions: biotic
- Flower development and fertilization
- Embryo and seed development
- Fruit development
- Senescence

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<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Semester</th>
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<tbody>
<tr>
<td>551-0307-00L</td>
<td>Biomolecular Structure and Mechanism I: Protein Structure and Function</td>
<td>W</td>
<td>3</td>
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</table>

**Abstract**

Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

**Objective**

Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytcs.

**Lecture notes**

Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
This course focuses on the concepts of classical and modern genetics and genomics. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccine

Prerequisites / notice
Lecture notes Scripts and additional material will be provided during the semester.

Literature
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

ECTS
3 credits

Lecture notes
No script

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.


Abstract
Structure, function and chemistry of nucleic acids and carbohydrates, DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Objective
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Content
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccine

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, C. M. Azzalin, B. Kommann, M. Peter

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Prerequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel.

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

ECTS
6 credits

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

551-090-00L  Concepts in Modern Genetics  W  6 credits  4V  Y. Barral, D. Bopp, A. Hajnal, O. Voinnet

Abstract
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics, gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective
This course focuses on the concepts of classical and modern genetics and genomics.

Content
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes
Scripts and additional material will be provided during the semester.

Prerequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UniZH Irchel.

551-0317-00L  Immunology I  W  3 credits  2V  A. Oxenius, M. Kopf

Abstract
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Objective
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Content
- Introduction and historical background
- Innate and adaptive immunity, cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- TH1 and TH2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Lecture notes
Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

Literature

Prerequisites / notice
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".


Abstract
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to the theoretical background of bioinformatics approaches. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content
Bioinformatics I will cover the following topics:
- From genes to databases and information
  - BLAST searches
  - Prediction of gene function and regulation
  - RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisions
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

376-1305-10L  Neurobiology  W  6 credits  4V  M. E. Schwab, E. Stoeckli, L. Fili, K. A. Martin, further lecturers

Abstract
Development of the nervous system (NS); the adult NS, plasticity and regeneration, sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, diseases of the NS.

Objective
Overview of normal development, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
Development: Early development of the nervous system, cellular level, nerve fiber growth, building of neuronal networks; biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.
Lecture notes
Structure, Plasticity and Repair of the Nervous System (376-1305-01L); Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Literature
Development of the Nervous System (376-1305-00L); Lecture notes will be provided on OLAT https://www.olat.uzh.ch/olat/dmz/
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures.

376-0205-00L Molecular Disease Mechanisms I W 6 credits 4V C. Wolfrum, C. Claudia, M. Ristow, M. Stoffel, A. Wutz, M. Zenobi-Wong
Abstract
The mechanisms of disease development will be studied. Main topics will be: Genetic regulation of disease development with a focus on monogenic and polygenic forms. In addition the methods used in elucidating genetic components in disease progression will be discussed. Ageing and disease associated changes including the underlying molecular mechanisms.
Objective
To understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components to understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components.

Elective Compulsory Master Courses

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-0512-00L</td>
<td>Current Topics in Molecular and Cellular Neurobiology</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>U. Suter</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course is a literature seminar or &quot;journal club&quot;. Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.</td>
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<tr>
<td>Objective</td>
<td>The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.</td>
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<tr>
<td>Content</td>
<td>You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.</td>
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<tr>
<td>Literature</td>
<td>We cover a range of themes related to development and neurobiology. Before starting your preparations, check with Jorge Pereira (<a href="mailto:jorge.pereira@bioi.ethz.ch">jorge.pereira@bioi.ethz.ch</a>), who helps you with finding an appropriate paper.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).</td>
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<tbody>
<tr>
<td>551-0571-00L</td>
<td>From DNA to Diversity (University of Zurich)</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. Hajnal, D. Bopp, E. Hafen</td>
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<tr>
<td>Abstract</td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO336</td>
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<tr>
<td>Notice</td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<tr>
<td>Objective</td>
<td>The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.</td>
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<tr>
<td>Content</td>
<td>By the end of this module, each student should be able to</td>
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<td>- recognize the universal principles underlying the development of different animal body plans.</td>
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<td>- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.</td>
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<td>- relate changes in gene structure or function to evolutionary changes in animal development.</td>
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<td>Key skills:</td>
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<td>- By the end of this module, each student should be able to</td>
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<td></td>
<td>- present and discuss a relevant evolutionary topic in an oral presentation</td>
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<td>- select and integrate key concepts in animal evolution from primary literature</td>
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<td>- participate in discussions on topics presented by others</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, T. J. Erb, J. Piel</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<tr>
<td>Objective</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.</td>
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<tr>
<td>Content</td>
<td>List of topics:</td>
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<td></td>
<td>Eating sugars and letting them inChallenging: Aromatics, xenobiotics, and oil</td>
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<tr>
<td></td>
<td>Complex: (Ligno-)Cellulose and in demand for bioenergy</td>
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<td>Living on a diet and the anaerobic provocation</td>
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<td>Of climate relevance: The microbial C1 cycle</td>
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<td>What are AMO and Anammox? 20 amino acids: the making of</td>
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<td>Extending the genetic code</td>
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<td>The 21st and 22nd amino acid Some exotic biochemistry: nucleotides, cofactors</td>
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<td>Ancient biochemistry? Iron-sulfur clusters, polymers</td>
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<td></td>
<td>Secondary metabolites: playground of evolution</td>
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</table>
Weekly seminar about cutting edge topics in immunology and infection biology. Internationally renowned experts present their current
research followed by an open discussion. The aim of this course is to confront students with current research topics and with scientific presentation. The course offers the opportunity to gain in depth knowledge about diverse topics which are often only briefly touched in the concept courses and to engage in discussion with experts in the field.

**Content**
Immunology and infection biology. The specific topics are variable and depend each semester on the list of invited experts.

**Prerequisites / notice**
The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

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**551-1153-00L**
Systems Biology of Metabolism

**Abstract**
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

**Objective**
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

**Content**
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

**Lecture notes**
Script and original publications will be supplied during the course.

**Prerequisites / notice**
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

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**551-1171-00L**
Immunology: from Milestones to Current Topics

**Abstract**
Milestones in Immunology: on old concepts and modern experiments

**Objective**
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptional framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

**Content**
Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

**Prerequisites / notice**
Original and review articles will be distributed by the lecturer. Literaturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-<app2.let.ethz.ch/course/view.php?id=1002

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**551-1303-00L**
Current Research Topics in Cell Biochemistry

**Abstract**
Introduction, presentation, evaluation, critical discussion and written analysis of recent scientific articles in the research area of cellular biochemistry.

**Objective**
The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

**Content**
The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

**Literature**
The relevant references to primary literature and review articles will be provided during the course.

**Prerequisites / notice**
The course will be taught in English.
In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

**Prerequisites / notice**
Active participation in the discussions is a prerequisite for this course.

### 529-0733-00L Enzymes

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<th>Number</th>
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<tbody>
<tr>
<td>529-0733-00L</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
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</table>

**Abstract**
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

**Objective**
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

**Content**
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

**Lecture notes**
A script will not be handed out.

**Literature**
General:

### 551-1409-00L RNA Biology Lecture Series II: Non-coding RNAs: Biology and Therapeutics

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<th>Number</th>
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<tr>
<td>551-1409-00L</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>J. Hall, M. Stoffel, O. Voinnet, further lecturers</td>
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</table>

**Abstract**
This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

**Objective**
The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

**Content**
Micro RNAs; computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomerases; tRNA biology.

**Prerequisites / notice**
Basic knowledge of cell and molecular biology.

#### Elective Major: Molecular Health Sciences

#### Compulsory Concept Courses

### Number Title Type ECTS Hours Lecturers

| 376-0205-00L | Molecular Disease Mechanisms I | W | 6 | 4V | C. Wolfrum, C. Ciaudo, M. Ristow, M. Stoffel, A. Wutz, M. Zenobi-Wong |

**Abstract**
The mechanisms of disease development will be studied. Main topics will be: Genetic regulation of disease development with a focus on monogenic and polygenic forms. In addition the methods used in elucidating genetic components in disease progression will be discussed. Ageing and development associated disease progression including the underlying molecular mechanisms.

**Objective**
To understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components to understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components.

### Elective Compulsory Master Courses

| 551-0571-00L | From DNA to Diversity (University of Zurich) | W | 2 | 2V | A. Hajnal, D. Bopp, E. Hafen |

**Abstract**
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: BIO336

**Mind the enrolment deadlines at UZH:**
http://www.uzh.ch/studies/application/mobilitaet_en.html

**Objective**
The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

### Elective Compulsory Master Courses

| 551-1303-00L | Current Research Topics in Cellular Biochemistry | W | 4 | 2S | V. Panse, C. M. Azzalin, V. Korkhov, R. Kroschewski, P. Picotti, A. E. Smith, F. van Drogen |

**Abstract**
Introduction, presentation, evaluation, critical discussion and written analysis of recent scientific articles in the research area of cellular biochemistry.

**Objective**
The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

**Content**
The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

**Literature**
The relevant references to primary literature and review articles will be provided during the course.

| 551-0512-00L | Current Topics in Molecular and Cellular Neurobiology | W | 2 | 1S | U. Suter |

**Abstract**
Number of participants limited to 8.

**Prerequisites / notice**
The course will be taught in English.
The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn, i.e., their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

Presentations will be made available after the seminars.

We cover a range of themes related to development and neurobiology. Before starting your preparations, check with Jorge Pereira (jorge.pereira@biol.ethz.ch), who helps you with finding an appropriate paper.

You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

Systems Biology of Metabolism

The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Students are able to evaluate the scientific evidence on the effects of diet on health, to describe the role of nutritional factors in the prevention of chronic diseases, to assess the nutritional status of a population (Switzerland taken as an example) and to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic and other threats to health are discussed.

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.
Objective 1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody’s Journey From Cell Culture to The Clinics.
7. Functional Food. Enjoy your Meal!

Lecture notes Handsout during the course.

752-4009-00L Molecular Biology of Foodborne Pathogens
Objective Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microbial organism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Content Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Prerequisites / Literature Recommendations will be given in the first lecture

752-6101-00L Nutrition and Chronic Disease (HS)
Objective To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Content The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Lecture notes There is no script. Powerpoint presentations will be made available on-line to students.

Prerequisites / Literature To be provided by the individual lecturers, at their discretion.

636-0507-00L Synthetic Biology II
Objective The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

Prerequisites / Literature Handsout during course

376-0300-00L Translational Science for Health and Medicine
Objective Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

Content What is translational science and what is it not?
- How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process

Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

551-1145-00L Viral and Non-Viral Vectors for Human Gene-Therapy - from Pathogens to Safe Medical Applications
Objective No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

Objective
Knowledge of important viral and non-viral vector systems.
Knowledge of application in human diseases.
Knowledge of limiting factors.

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<th>Number</th>
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<tbody>
<tr>
<td>551-1409-00L</td>
<td>RNA Biology Lecture Series II: Non-coding RNAs: Biology and Therapeutics</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>J. Hall, M. Stoffel, O. Voinnet, further lecturers</td>
</tr>
</tbody>
</table>

Abstract
This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

Objective
The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

Content
Micro RNAs; computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; nucleic acid-based drugs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in citalites; telomerase and telomerases; TRNA biology.

ECTS
Title: C. M. Azzalin,
Hours: 2S 2V

Introduction, presentation, evaluation, critical discussion and written analysis of recent scientific articles in the research area of cellular biochemistry.

The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

The relevant references to primary literature and review articles will be provided during the course.

The course will be taught in English.

Elective Major: Biochemistry

Elective Concept Courses

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>U. Kutay, C. M. Azzalin, B. Kornmann, M. Peter</td>
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Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

The course will be taught in English.

Compulsory Master Course

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<th>Number</th>
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<tr>
<td>551-1303-00L</td>
<td>Current Research Topics in Cellular Biochemistry Number of participants limited to 15.</td>
<td>O</td>
<td>4 credits</td>
<td>2S</td>
<td>V. Panse, C. M. Azzalin, V. Korkhov, R. Kroschewski, P. Picotti, A. E. Smith, F. van Drogen</td>
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</table>

Abstract
Introduction, presentation, evaluation, critical discussion and written analysis of recent scientific articles in the research area of cellular biochemistry.

Objective
The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

Content
The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

Literature
The relevant references to primary literature and review articles will be provided during the course.

The course will be taught in English.

Elective Compulsory Concept Courses

See D-BIOL Master Studies Guide

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<th>Number</th>
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<tr>
<td>551-0307-00L</td>
<td>Biomolecular Structure and Mechanism I: Protein Structure and Function D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Barr</td>
</tr>
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Abstract
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current methods as well as modern methods for protein purification and microanalytic.

Objective
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytic.

Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

The course will be taught in English.

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 222 of 1432
Abstract

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective

This course focuses on the concepts of classical and modern genetics and genomics.

Content

The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes

Scripts and additional material will be provided during the semester.

Prerequisites / notice

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel.

Number of participants limited to 15.

Data: 06.12.2018 13:04

Autumn Semester 2015

Page 223 of 1432
Objective
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes
Script and original publications will be supplied during the course.

Prerequisites / notice
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

636-0001-00L
Separations in Biotechnology and Bioprocess Economy

Objective
Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Content
Introduction membrane operations adsorption and chromatography crystallization overall process economics

Lecture notes
Handouts during course

636-0007-00L
Computational Systems Biology

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear models. The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

636-0003-00L
Biological Engineering and Biotechnology

Objective
Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Content
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

Lecture notes
Handsout during the course.
551-0307-00L **Biomolecular Structure and Mechanism I: Protein Structure and Function**

**Abstract**
Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

**Objective**
Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

**Content**
Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation. Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods. Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods). Employment of computer science for processing data in chemical analysis (chemometrics).

**Lecture notes**
lecture notes will be available in the lecture at production cost.

**Prerequisites / notice**
Information about relevant literature will be available in the lecture & in the lecture notes.

**Prerequisites**
- 529-0051-00 "Analytische Chemie I (3. Semester)"
- 529-0058-00 "Analytische Chemie II (4. Semester)" (or equivalent)

551-1409-00L **RNA Biology Lecture Series II: Non-coding RNAs**

**Title**
RNA Biology and Therapeutics

**Abstract**
This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

**Objective**
The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

**Content**
Micro RNAs: computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs: nucleic acid-based drugs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; tRNA biology.

**Prerequisites / notice**
Basic knowledge of cell and molecular biology.

**Prerequisites**
- 551-0307-00L "Biomolecular Structure and Mechanism I: Protein Structure and Function"
- 551-0309-00L "Concepts in Modern Genetics"
- 551-0313-00L "Microbiology (Part I)"
- 551-0317-00L "Immunology I"

**ECTS**
3 credits

**Hours**
2V

**Lecturers**
J. Hall, M. Stoffel, O. Voinnet, further lecturers

**Literature**

**Data:** 06.12.2018 13:04

**Autumn Semester 2015**
Content
- Introduction and historical background
- Innate and adaptive immunity. Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histoincompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Lecture notes
Electronic access to the documentation will be provided. The link can be found at “Lernmaterialien”

Literature

Prerequisites / notice
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a “Sessionsprüfung”.

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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Objective
The new course "Molecular Life of Plants" reflects the rapid advances that are occurring in the field of experimental plant biology as well as the changing interests of students being trained in this discipline. Contemporary plant biology courses emphasize a traditional approach to experimental plant biology by discussing discrete topics that are removed from the context of the plant life cycle. The course will take an integrative approach that focuses on developmental concepts. Where traditional plant physiology courses were based on research carried out on intact plants or plant organs and were often based on phenomenological observations, current research in plant biology emphasizes work at the cellular, subcellular and molecular levels.

The goal of "Molecular Life of Plants" is to train students in integrative approaches to understand the function of plants in a developmental context. While the course focuses on plants, the training integrative approaches will also be useful for other organisms.
The course "Molecular Life of Plants" will cover the following topics in a developmental context:

- Plant genome organization
- Seed anatomy
- Food reserves and mobilization
- Seedling emergence
- Heterotrophic to autotrophic growth
- Chlorophyll biosynthesis, photoreceptors
- Integration of metabolism
  - Hormones
  - Cell cycle
  - Cell differentiation and expansion
- Environmental interactions
  - Abiotic
  - Biotic
- Flower development and fertilization
- Embryo and seed development
- Fruit development
- Senescence

#### Elective Compulsory Concept Courses

*See D-BIOL Master Studies Guide*

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<tbody>
<tr>
<td>551-0307-00L</td>
<td>Biomorphic Structure and Mechanism I: Protein Structure and Function (next semester) as a two-semester course</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
</tr>
</tbody>
</table>

- Abstract
  - Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.
- Objective
  - Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.
- Literature
  - Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.
- Prerequisites / notice
  - Current topics: References will be given during the lectures.

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<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6</td>
<td>4V</td>
<td>Y. Barral, D. Bopp, A. Hajnal, O. Voinnet</td>
</tr>
</tbody>
</table>

- Abstract
  - Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.
- Objective
  - This course focuses on the concepts of classical and modern genetics and genomics.
- Content
  - The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.
- Prerequisites / notice
  - This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UniZH Irchel.

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<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer</td>
</tr>
</tbody>
</table>

- Abstract
  - Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.
- Objective
  - This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.
- Content
  - Advanced class covering the state of research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.
- Prerequisites / notice
  - The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

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<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>U. Kutay, C. M. Azzalin, B. Kornmann, M. Peter</td>
</tr>
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</table>

- Abstract
  - Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.
- Objective
  - The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.
- Content
  - The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.
- Lecture notes
  - Updated handouts will be provided during the class.
  - The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

Please contact Dr. Alicia Smith for assistance with the learning materials: Alicia.smith@bc.biol.ethz.ch
### 551-1295-00L Introduction to Bioinformatics: Concepts and Applications

| W | 6 credits | 4G | W. Gruissem, K. Bärenfaller, M. Robinson, A. Wagner |

**Abstract**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

**Objective**

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be exposed to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Content**

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

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### 701-2413-00L Evolutionary Genetics

| W | 6 credits | 4V | T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer, A. Guggisberg |

**Abstract**

The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

**Objective**

The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

**Content**

Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.

Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossing effects on fitness; Fisher's fundamental theorem.

Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation.

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#### Elective Compulsory Master Courses

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<tbody>
<tr>
<td>751-4801-00L</td>
<td>System-Oriented Management of Herbivore Insects I</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>D. Mazzi</td>
</tr>
</tbody>
</table>

**Abstract**

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

**Objective**

The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.

| 551-1105-00L | Glycobiology | W | 4 credits | 2V | M. Aebi, T. Hennet |

**Abstract**

Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

**Objective**

Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycochemistry, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

**Content**

Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminylglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease.

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Data: 06.12.2018 13:04  Autumn Semester 2015  Page 228 of 1432
### 551-1103-00L Microbial Biochemistry

**W** 4 credits 2V

**J. Vorholt-Zambelli, T. J. Erb, J. Piel**

**Abstract**
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

**Objective**

**Content**

- Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

- List of topics:
  - Eating sugars and letting them in
  - Challenging: Aromatics, xenobiotics, and oil
  - Complex: (Ligno-)Cellulose and in demand for bioenergy
  - Of climate relevance: The microbial C1 cycle
  - What are AMO and Anammox?
  - 20 amino acids: the making of
  - Extending the generic code
  - The 21st and 22nd amino acid
  - Some exotic biochemistry: nucleotides, cofactors
  - Ancient biochemistry? Iron-sulfur clusters, polymers
  - Secondary metabolites: playground of evolution

**Lecture notes**
A script will be provided during the course.

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### 529-0733-00L Enzymes

**W** 7 credits 3G

**D. Hilvert**

**Abstract**
The principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

**Objective**

**Content**

- Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

- Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

**Lecture notes**
A script will not be handed out.

**Literature**

**General:**

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

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### 751-5121-00L Insect Ecology

**W** 2 credits 2V

**S. Halloran, C. De Moraes, M. Mescher**

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

**Objective**

**Content**

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

**Lecture notes**
Provided to students through IILAS.

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

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### 551-1153-00L Systems Biology of Metabolism

**W** 4 credits 2V

**U. Sauer, N. Zamboni, M. Zampieri**

**Number of participants limited to 15.**

**Abstract**
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

**Objective**

**Content**

- Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

**Lecture notes**
Script and original publications will be supplied during the course.

**Prerequisites / notice**
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

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

**W** 2 credits 2G

**F. Talas, B. McDonald, J. Palma Guerrero, A. Sanchez Vallet**

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

**Objective**

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

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

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

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


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

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

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

Week 8  Pathogen effects on food quality and safety.

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

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

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

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

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

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

Lecture notes

Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.
Current topics: References will be given during the lectures.

551-0309-00L  Concepts in Modern Genetics  W 6 credits  4V  Y. Barrai, D. Bopp, A. Hajnal, O. Voinnet

Abstract  Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective  This course focuses on the concepts of classical and modern genetics and genomics.

Content  The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes  Scripts and additional material will be provided during the semester.

Prerequisites / notice  This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UniZH Irchel.

551-0313-00L  Microbiology (Part I)  W 3 credits  2V  W.D. Hardt, L. Ebert, H.M. Fischer, J. Piel, M. Pilhofer

Abstract  Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective  This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content  Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes  Updated handouts will be provided during the class.

Literature  Current literature references will be provided during the lectures.

Prerequisites / notice  English  The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

551-0319-00L  Cellular Biochemistry (Part I)  W 3 credits  2V  U. Kutay, C. M. Azzalin, B. Kommann, M. Peter

Abstract  Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective  The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

Content  Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Lecture notes  Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature  Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice  To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

551-1295-00L  Introduction to Bioinformatics: Concepts and Applications  W 6 credits  4G  W. Gruissem, K. Bärenfaller, A. Callfisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner

Abstract  Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications in bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective  Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogentic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.
Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Elective Major: Systems Biology

Elective Compulsory Concept Courses

See D-BIOL Master Studies Guide

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<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>U. Kutay, C. M. Azzalin, B. Kommann, M. Peter</td>
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<tr>
<td>Objective</td>
<td>The full-year course (551-0319-00 &amp; 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.</td>
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<tr>
<td>Content</td>
<td>Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.</td>
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<tr>
<td>Lecture notes</td>
<td>Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (<a href="mailto:alicia.smith@bc.biol.ethz.ch">alicia.smith@bc.biol.ethz.ch</a>)</td>
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<tr>
<td>Literature</td>
<td>Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.</td>
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</table>

| 551-0309-00L | Concepts in Modern Genetics                   | W    | 6 credits | 4V    | Y. Barral, D. Bopp, A. Hajnal, O. Voinnet |
| Abstract    | Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference. |
| Objective   | This course focuses on the concepts of classical and modern genetics and genomics. |
| Content     | The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference. |
| Lecture notes | Scripts and additional material will be provided during the semester. |
| Prerequisites / notice | This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel. |

| 551-0313-00L | Microbiology (Part I)                         | W    | 3 credits | 2V    | W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer |
| Abstract     | Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. |
| Objective    | This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. |
| Content      | Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. |
| Lecture notes | Updated handouts will be provided during the class. |
| Literature   | Current literature references will be provided during the lectures. |
| Prerequisites / notice | English |

| Abstract     | Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis. |

Objective

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic processes, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Elective Compulsory Master Courses I: Computational

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>J. Stelling</td>
</tr>
<tr>
<td>Abstract</td>
<td>Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).</td>
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<tr>
<td>Objective</td>
<td>The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.</td>
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<tr>
<td>Content</td>
<td>Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label &quot;Systems Biology&quot;, focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks. We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.</td>
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</table>

252-0523-00L   | Computational Biology               | W    | 6 credits | 3V+2U | G. H. Gonnet     |
| Abstract      | Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis. |
| Objective     | Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied. |
| Content       | This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite. |

Elective Compulsory Master Courses II: Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, T. J. Erb, J. Piel</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<tr>
<td>Objective</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.</td>
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</tbody>
</table>
Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaerobic provocation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anamox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

Lecture notes
A script will be provided during the course.

551-1153-00L Systems Biology of Metabolism
Number of participants limited to 15.

Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes
Script and original publications will be supplied during the course.

Prerequisites / notice
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

636-0001-00L Separations in Biotechnology and Bioprocess
Economy

Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

Objective
Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Content
Introduction membrane operations adsorption and chromatography crystallization overall process economics

Lecture notes
Handouts during course

636-0507-00L Synthetic Biology II

7 months biological design project, during which the students are required to give presentations in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content
Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes
Handouts during course

Prerequisites / notice
The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc. This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

551-0571-00L From DNA to Diversity (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. 

UZH Module Code: BIO336

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilietaet_en.html

Abstract
The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective
By the end of this module, each student should be able to
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
By the end of this module, each student should be able to
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

636-0009-00L Evolutionary Dynamics

W 5 credits 2V+1U N. Beerweninkel
Evolutionary dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.

The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.

Evolution is the one theory that encompasses all of biology. It provides a single, unifying concept to understand the living systems that we observe today. We will introduce several types of mathematical models of evolution to describe gene frequency changes over time in the context of different biological systems, focusing on asexual populations. Viruses and cancer cells provide the most prominent examples of such systems and they are at the same time of great biomedical interest. The course will cover some classical mathematical population genetics and population dynamics, and also introduce several new approaches. This is reflected in a diverse set of mathematical concepts which make their appearance throughout the course, all of which are introduced from scratch. Topics covered include the quasispecies equation, evolution of HIV, evolutionary game theory, birth-death processes, evolutionary stability, evolutionary graph theory, somatic evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

No.


Prerequisites: Basic mathematics (linear algebra, calculus, probability)

### Elective Major: Structural Biology and Biophysics

#### Compulsory Concept Courses

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
551-0307-00L | Biomolecular Structure and Mechanism I: Protein Structure and Function | O | 3 credits | 2V | R. Glockshuber, K. Locher, E. Weber-Ban

**Abstract**
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

**Objective**
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

**Lecture notes**
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

**Literature**
Basics:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

### Elective Compulsory Concept Courses

See D-BIOL Master Studies Guide
### Concept in Modern Genetics

**Lecture notes**
Updated handouts will be provided during the class.

**Literature**
Current literature references will be provided during the lectures.

**Prerequisites / notice**
The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

**Content**
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Objective**
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel.

### Bioinformatics I: Concepts and Applications

**Abstract**
Introduction to Bioinformatics: Concepts and Applications

**Objective**
Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

**Course Information**
- **Number**: 551-1295-00L
- **ECTS**: 6 credits
- **Type**: 4G
- **Instructors**: W. Gruissem, K. Bärenfaller, A. Calligis, G. Capitani, J. Fütterer, M. Robinson, A. Wagner

### Modern Genetics

**Abstract**
Concepts in Modern Genetics

**Objective**
This course focuses on the concepts of classical and modern genetics and genomics.

**Course Information**
- **Number**: 551-0309-00L
- **ECTS**: 6 credits
- **Type**: 4V
- **Instructors**: Y. Barral, D. Bopp, A. Hajnal, O. Vaninnet

### Elective Compulsory Master Courses

#### Enzymes

**Abstract**
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

**Objective**
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

**Course Information**
- **Number**: 529-0733-00L
- **ECTS**: 7 credits
- **Type**: 3G
- **Instructors**: D. Hilvert

#### Glycobiochemistry

**Abstract**
Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

**Objective**
Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiochemistry, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

**Course Information**
- **Number**: 551-1105-00L
- **ECTS**: 4 credits
- **Type**: 2V
- **Instructors**: M. Aebi, T. Hen nett

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**Data**: 06.12.2018 13:04  **Autumn Semester 2015**  **Page 236 of 1432**
Content: Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

Lecture notes: handouts


Prerequisites / notice: The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1103-00L Microbial Biochemistry  W 4 credits 2V J. Vorholt-Zambelli, T. J. Erb, J. Piel

Abstract: The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

Objective: The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.

Content: Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of modern generation and assimilation.

List of topics:
- Eating sugars and letting them in Challenging: Aromatics, xenobiotics, and oil Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaerobic provocation Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of Extending the genetic code
- The 21st and 22nd amino acid Some exotic biochemistry: nucleotides, cofactors

Lecture notes: A script will be provided during the course.

551-1401-00L Advanced Protein Engineering (University of Zurich)  W 2 credits 2G A. Plückthun

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BCH420

Restricted to max. 10 students from ETH

Abstract: Introduction into current research strategies in protein science.

Objective: To understand current research strategies in protein science.

Content: Proteins have become an object of intense study in modern science, ranging from their use as therapeutics to elucidating their structure and function in the cell. Moreover, it is now possible to engineer and evolve tailor-made proteins, opening up many new areas of science. This course will attempt to cover the frontiers and remaining challenges, emphasizing the biochemical foundations of the various approaches.

Lecture notes: Slides and references will be available on OLAT server.

Literature: PDFs will be available on OLAT server.

Prerequisites / notice: Solid knowledge in biochemistry strongly recommended.

551-1153-00L Systems Biology of Metabolism  W 4 credits 2V U. Sauer, N. Zamboni, M. Zampieri

Abstract: Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective: Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content: The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes: Script and original publications will be supplied during the course.

Prerequisites / notice: Solid knowledge in biochemistry strongly recommended.

529-0004-00L Computer Simulation in Chemistry, Biology and Physics  W 7 credits 4G P. H. Hünenberger

Abstract: Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Objective: For more information: www.csms.ethz.ch/education/CSCBP

Content: Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Literature: Available (copies of powerpoint slides distributed before each lecture)

See: www.csms.ethz.ch/education/CSCBP
### Prerequisites / notice
Since the exercises on the computer do convey test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

### 401-0649-00L Applied Statistical Regression

<table>
<thead>
<tr>
<th>W</th>
<th>5 credits</th>
<th>2V+1U</th>
<th>M. Dettling</th>
</tr>
</thead>
</table>

**Abstract**
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student’s own projects and daily work life.

**Objective**
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

**Content**
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

**Lecture notes**
A script will be available.

**Literature**
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

**Prerequisites / notice**
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

### 401-6215-00L Using R for Data Analysis and Graphics (Part I)

<table>
<thead>
<tr>
<th>W</th>
<th>1 credit</th>
<th>1G</th>
<th>A. J. Papritz, C. B. Schwierz</th>
</tr>
</thead>
</table>

**Abstract**
The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

**Objective**
The students will be able to use the software R for simple data analysis.

**Content**
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

**Lecture notes**
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

**Prerequisites / notice**
The course resources will be provided via the Moodle web learning platform Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course “Using R for Data Analysis and Graphics” and follow the instructions for registration.

### 529-0041-00L Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>3G</th>
<th>R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano Sines</th>
</tr>
</thead>
</table>

**Abstract**
Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

**Objective**
Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

**Content**
Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation.
Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods.
Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods).
Employment of computer science for processing data in chemical analysis (chemometrics).

**Lecture notes**
lecture notes will be available in the lecture at production cost.

**Literature**
information about relevant literature will be available in the lecture & in the lecture notes.

**Prerequisites / notice**
Exercises are an integral part of the lecture.
Exercises are in the lecture notes.

Prerequisites: 529-0051-00 "Analytische Chemie I (3. Semester)"
529-0058-00 "Analytische Chemie II (4. Semester)"
(or equivalent)

### 551-1409-00L RNA Biology Lecture Series II: Non-coding RNAs:

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>2V</th>
<th>J. Hall, M. Stoffel, O. Voinnet, further lecturers</th>
</tr>
</thead>
</table>

**Abstract**
This covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

**Objective**
The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

**Content**
Micro RNAs; computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; nucleic acid-based drugs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; tRNA biology.

### Elective Major: Biological Chemistry

#### Compulsory Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Objective**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Content**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Lecture notes**

**Literature**
Mainly based on recent original literature, a detailed list will be distributed during the first lecture

### Elective Compulsory Master Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W</td>
<td>6 credits</td>
<td>3V</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

**Abstract**
Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

**Objective**

**Lecture notes**
Handout during the course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0004-00L</td>
<td>Computer Simulation in Chemistry, Biology and Physics</td>
<td>W</td>
<td>7 credits</td>
<td>4G</td>
<td>P. H. Hünenberger</td>
</tr>
</tbody>
</table>

**Abstract**
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation

**Objective**
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

**Content**
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation

**Lecture notes**
Available (copies of powerpoint slides distributed before each lecture)

**Literature**
See: www.csms.ethz.ch/education/CSCBP

**Prerequisites / notice**
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

**For more information please visit:**
www.csms.ethz.ch/education/CSCBP

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0241-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>J. W. Bode</td>
</tr>
</tbody>
</table>

**Abstract**
Advanced Modern Methods and Strategies in Synthesis

**Objective**
Knowledge of modern methods in asymmetric stereocntrol, enantioselective catalysis, and organic reaction mechanisms.

**Content**
Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precedents, and emerging topics will be emphasized.

**Lecture notes**
will be provided in class and online

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**Data: 06.12.2018 13:04**

Autumn Semester 2015
529-0233-00L Organic Synthesis: Methods and Strategies

**Abstract**
The complex relation between structural analysis, methods leading to desired transformations, and insight into reaction mechanisms is exemplified. Relations between retrosynthetic analysis of target structures, synthetic methods and their combination in a synthetic strategy.

**Objective**
Extension and deepening of the knowledge in organic synthesis.

**Content**

**Literature**

**Prerequisites / notice**
OC I-IV

529-0243-00L Reactive Intermediates

**Abstract**
Advanced physical organic chemistry. Methods for the elucidation of reaction mechanisms. Reactive intermediates. Thermochrometry; isotope labeling; cross-over experiments; kinetic isotope effects; thermodynamics-kinetics correlations; solvation and ion pairs; radical reactions; electron transfer; spectroscopic methods.

**Objective**
Methods for the elucidation of organic reaction mechanisms.

**Content**

**Literature**
A printed script are handed out in the course. This material is also available for download from the web page of the course (as pdf files).

**Lecture notes**
Each participant is expected to contribute to a 30 min. seminar (prepared by groups of 2-4 students), presented in the last weeks of the semester.

**Prerequisites / notice**
Required level: Courses in organic and physical chemistry of the first and second year.

529-0041-00L Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics

**Abstract**
Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

**Objective**
Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

**Content**
Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation. Modern mass spectrometry: time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods. Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods). Employment of computer science for processing data in chemical analysis (chemometrics).

**Literature**
Additional reading and original publications are cited in the lectures.

**Lecture notes**
Course notes will be available in the lecture at production cost.

**Notice**
Information about relevant literature will be available in the lecture & in the lecture notes.

**Prerequisites**
Exercises are an integral part of the lecture.

---

551-1409-00L RNA Biology Lecture Series II: Non-coding RNAs: Biology and Therapeutics

**Abstract**
This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

**Objective**
The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

**Content**
Micro RNAs; computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; nucleic acid-based drugs; RNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; TRNA biology.

**Prerequisites / notice**
Basic knowledge of cell and molecular biology.

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**E elective Concept Courses**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-0307-00L</td>
<td>Biomolecular Structure and Mechanism I: Protein Structure and Function</td>
<td>W</td>
<td>3</td>
<td>2</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
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<tr>
<td></td>
<td><strong>D-BIOL BSc students are obliged to take part I and part II</strong> (next semester) as a two-semester course</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
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<td></td>
<td>Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td>Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.</td>
</tr>
<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
<td></td>
<td></td>
<td></td>
<td>Scripts on the individual topics can be found under <a href="http://www.mol.biol.ethz.ch/teaching">http://www.mol.biol.ethz.ch/teaching</a>. Basics:</td>
</tr>
<tr>
<td></td>
<td><strong>Literature</strong></td>
<td></td>
<td></td>
<td></td>
<td>- Creighton, T.E., Proteins, Freeman, (1993)</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>- Fersht, A., Enzyme Structure and Mechanism in Protein Science (1999), Freeman.</td>
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<tr>
<td></td>
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<td></td>
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<td></td>
<td>Current topics: References will be given during the lectures.</td>
</tr>
</tbody>
</table>

| 551-0319-00L | Cellular Biochemistry (Part I)                                      | W    | 3    | 2    | U. Kutay, C. M. Azzalin, B. Kommann, M. Peter |
|              | **Abstract**                                                       |      |      |      | Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration. |
Objective

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecture notes

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Prerequisites / notice

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

Recommended Elective Courses (for all Master Majors)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0180-00L</td>
<td>Research Ethics ■</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>G. Achermann</td>
</tr>
</tbody>
</table>

- Particularly suitable for students of D-BIOL, D-CHAB, D-HEST

Abstract

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not ...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is “integrity” in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
- Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
- Recommended literature:
  - "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

Research Projects (for all Master Majors)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1801-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>15 credits</td>
<td>34A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Research projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.
Research Project II

Abstract
Research projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-BIOL:

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1800-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme;
c. have acquired at least 30 credits in the category "research projects".

Abstract
The Master research will be carried out on a theme in the chosen subject area and must be completed with a written report (Thesis) within six months.

Master Examination

see Study Regulations 2006 for the Master-curriculum Biology, Art. 38

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1800-01L</td>
<td>Master's Examination</td>
<td>O</td>
<td>4</td>
<td></td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are admitted for the master examination

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
The Master examination comprises a written part and an oral part. Both parts will receive an evaluation mark. The Master examination is passed when the arithmetic mean of both evaluation marks is at least 4. The Master examination must be taken within three months of submitting the thesis.

Biology Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Microrobotics

**Objective**
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Literature**
- G. Kovacs: Micromachined Transducer Sourcebook
- W. Menz, J. Mohr, O.Paul: Microsystem Technology
- S. M. Sze: Semiconductor Devices, Physics and Technology

**Prerequisites / notice**
The lecture will be taught in English.

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### Nanosystems

**Objective**
Familiarize students with basic science and engineering principles governing the nano domain. We particularly work out the links between topics that are traditionally taught separately.

**Content**
The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

**Literature**

**Prerequisites / notice**
- From Quantum to Continuum
- From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.
- Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.
- Special emphasis on the emerging field of molecular electronic devices.

**Homework:** Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

---

### Microsystems Technology

**Objective**
Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and -devices by a sequence of defined processing steps (process flow).

**Content**
- Introduction to microsystems technology (MST) and micro electro mechanical systems (MEMS)
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.
- Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.

**Literature**
- S. M. Sze: Semiconductor Devices, Physics and Technology
- C. Hierold, M. Haluska: Micromachined Transducer Sourcebook

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**Lectures and Mini-Review presentations:** Thursday 10-13, ML F 36

**Homework:** Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.
**Biomedical Imaging**

New course. Not to be confounded with 227-0385-00L of fall 2014.

**Abstract**
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

**Objective**
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

**Content**
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Lecture notes**
Lecture notes and handouts

**Literature**
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

**Prerequisites / notice**
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

**Biomedical Engineering**

**Abstract**
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

**Objective**
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

**Content**

**Lecture notes**
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

**Signal and Information Processing: Modeling, Filtering, Learning**

**Abstract**
Fundamentals in signal processing, detection/estimation, and machine learning.
I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparseness.

**Objective**
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

**Content**

**Lecture notes**
Lecture notes.

**Prerequisites / notice**
- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

**Biocompatible Materials**

**Abstract**
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

**Objective**
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

**Content**
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.
In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Lecture notes**
Handouts can be accessed online.
Handouts provided during the classes and references therin.

402-0674-00L

Physics in Medical Research: From Atoms to Cells

W 6 credits 2V+1U B. K. R. Müller

Abstract

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metals to complex organic materials. The knowledge is extended to optical and electronic properties as well as to proteins and cells.

Objective

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/adsorption and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidative and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantifyed by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichromism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

227-1037-00L

Introduction to Neuroinformatics

W 6 credits 2V+1U K. A. Martin, M. Cook, V. Mante, M. Pfeiffer

Abstract

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, math, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content

This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electrophysiological properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local information of nerve connections are captured by topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

Recommended Elective Courses

These courses are particularly recommended for the Bioelectronics track. Please consult your track advisor if you wish to select other subjects.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
227-0166-00L | Analog Integrated Circuits | W | 6 credits | 2V+2U | Q. Huang

Abstract

This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies. Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

Objective

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

Content

Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.

The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurents.

Lecture notes

Handouts of presented slides. No script but an accompanying textbook is recommended.

Literature

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>W Credits</th>
<th>V+U Credits</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0474-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>6</td>
<td>3+1U</td>
<td>G. Székely, O. Göksel, L. Van Gool</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td>Light and perception. Digital image formation. Image enhancement and feature extraction. Unitary transformations. Color and texture. Image segmentation and deformable shape matching. Motion extraction and tracking. 3D data extraction. Invariant features. Specific object recognition and object class recognition.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
<td></td>
<td></td>
<td>Course material Script, computer demonstrations, exercises and problem solutions</td>
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<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.</td>
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<tr>
<td>227-0468-00L</td>
<td>Analog Signal Processing and Filtering</td>
<td>6</td>
<td>2V+2U</td>
<td>H. Schmid</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Suitable for Master Students as well as Doctoral Students. This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers.</td>
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<td><strong>Objective</strong></td>
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<td>The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.</td>
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<td><strong>Content</strong></td>
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<td>At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active Filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level. The lecture is suitable for both analog and digital designers. The way the exam is done allows for the different interests of the two groups.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td>The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria ...) and of the main properties of linear systems is necessary.</td>
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<tr>
<td>227-0981-00L</td>
<td>Cross-Disciplinary Research and Development in Medicine and Engineering</td>
<td>4</td>
<td>2V+2A</td>
<td>V. Kurtcuoglu, D. de Julien de Zelicourt, M. Meboldt, M. Schmid Daners, O. Ullrich</td>
</tr>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>A maximum of 12 medical degree students and 12 (biomedical) engineering degree students can be admitted, their number should be equal. Cross-disciplinary collaboration between engineers and medical doctors is indispensable for innovation in health care. This course will bring together engineering students from ETH Zurich and medical students from the University of Zurich to experience the rewards and challenges of such interdisciplinary work in a project-based learning environment.</td>
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<td><strong>Objective</strong></td>
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<td>The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since such differences become the most evident during actual collaborative work, the course is based on a current project in physiology research that combines medicine and engineering. For the engineering students, the specific aims of the course are to:</td>
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<td>- Acquire a working understanding of the anatomy and physiology of the investigated system;</td>
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<td>- Identify the engineering challenges in the project and communicate them to the medical students;</td>
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<td>- Develop and implement, together with the medical students, solution strategies for the identified challenges;</td>
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<td>- Present the found solutions to a cross-disciplinary audience.</td>
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<td><strong>Content</strong></td>
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<td>After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team presenting their solution to a cross-disciplinary audience.</td>
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<td><strong>Lecture notes</strong></td>
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<td>Handouts and relevant literature will be provided.</td>
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<tr>
<td>227-1032-00L</td>
<td>Neuromorphic Engineering I</td>
<td>6</td>
<td>2V+3U</td>
<td>T. Delbrück, G. Indiveri, S.C. Liu</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td>Understanding of the characteristics of neuromorphic circuit elements.</td>
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</table>

Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implemations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.


Prerequisites: Background in basics of semiconductor physics helpful, but not required.

**227-2037-00L**

**Physical Modelling and Simulation**
W 5 credits 4G C. Hafner, J. Leuthold, J. Smajic

**Abstract**
Physical modelling plays an important role in the analysis and design of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied.

**Objective**
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained.

**Content**
Since the fabrication and characterization of micro- and nanostructures is difficult, expensive, and time-consuming, numerical modelling drastically reduced the design process. Although many commercial software packages are available, it is important to know the drawbacks and difficulties of the numerical methods behind them and to be able to validate the results obtained with such packages.

First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the problems to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electromagnetics to multiphysics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

**151-0255-00L**

**Energy Conversion and Transport in Biosystems**
W 4 credits 2V+1U D. Poulikakos, A. Ferrari

**Abstract**
Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.

**Objective**
Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.

**Content**
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

**Literature**
Lecture notes and references therein.

**151-0509-00L**

**Microscale Acoustofluidics**
W 4 credits 3G J. Dual

**Abstract**
In this lecture the basics as well as practical aspects (from modelling to design and fabrication ) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

**Objective**
Understanding acoustophoresis, the design of devices and potential applications

**Content**
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity. Gorkov potential, numerical modelling, acoustic streaming, acoustic microactuators, etc. - and how to use them in microchip systems, systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of acoustofluidic systems, from elementary devices to systems.

**Literature**

**Prerequisites / notice**
Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

**252-0523-00L**

**Computational Biology**
W 6 credits 3V+2U G. H. Gonnert

**Abstract**
Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

**Objective**
Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

**Content**
This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of e.g., in, protein and DNA sequence alignment and its

**376-1103-00L**

**Frontiers in Nanotechnology**
W 4 credits 4V V. Vogel, further lecturers

**Abstract**
Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.
Objective

Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Content

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Lecture notes

All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

376-1219-00L Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions

Abstract

Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective

Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

Content

Introduction, problem definition, overview
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
  - Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
  - Rehabilitation and use of kinesthetic and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
  - Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
  - Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
  - Brain stimulation and recording
  - Deep brain stimulation for patients with Parkinson, epilepsy, depression
  - Brain-Computer Interfaces

Autumn Semester 2015
Introductory Books:


Micro/Nanotechnology and Microfluidics for E. Delamarche

Mostly formal lectures (2 × 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3

A. de Mello

Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unprilled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

Prerequisites / notice

Target Group:

Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome

Abstract

This course is an introduction to techniques in micro/nanotechnology and to microfluidics. It reviews how many familiar devices are built and can be used for research and biomedical applications. Transistors for DNA sequencing, bearmers for patterning proteins, hard-disk technology for biosensing and scanning microfluidics for analyzing tissue sections are just a few examples of the covered topics.

Objective

The main objective of the course is to introduce micro/nanotechnology and microfluidics to students having a background in the life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how micro/nanotechnology pervades throughout life sciences. Microfluidics will be emphasized due to their increasing importance in research and medical applications. The second objective is to have life students less intimidated by micro/nanotechnology and make them able to link instruments and techniques to specific problems that they might have in their projects/studies. This will also help students getting access to the ETHZ/IBM Nanotech Center infrastructure if needed.

Content

Mostly formal lectures (2 × 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).

Prerequisites / notice

Nanotech center and lab visit at IBM would be mandatory, as well as attending the student project presentations.

Abstract

Selected Journal Articles and Web Links:


VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

Target Group:

Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome
In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Specific topics in the course include, but not limited to:
1. Theoretical Concepts
   Features of mass and thermal transport on the microscale
   Key scaling laws
2. Microfluidic Device Manufacture
   Conventional lithographic processing of rigid materials
   Soft lithographic processing of plastics and polymers
   Mass fabrication of polymeric devices
3. Unit operations and functional components
   Analytical separations (electrophoresis and chromatography)
   Chemical and biological synthesis
   Sample pre-treatment (filtration, SPE, pre-concentration)
   Molecular detection
4. Design Workshop
   Design of microfluidic architectures for PCR, distillation & mixing
5. Contemporary Applications in Biological Analysis
   Microarrays
   Cellular analyses (single cells, enzymatic assays, cell sorting)
   Proteomics
6. System integration
   Applications in radiochemistry, diagnostics and high-throughput experimentation

Lecture notes
Lecture handouts, background literature, problem sheets and notes will be provided electronically.

636-0003-00L

Biological Engineering and Biotechnology

W 6 credits
3V M. Fussenegger

Abstract
Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective
1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines
3. Everything Under Control I. Regulated Transgene Expression in Mammalian Cells - Facts and Future
5. From Target To Market. An Antibody's Journey From Cell Culture to Development of Biological Weapons?
7. 8. Industrial Genomics. Getting a Systems View on Nutrition and Health - An Industrial Perspective
8. 9. IP Management - Food Technology. Protecting Your Knowledge For Business
9. 10. Biopharmaceutical Manufacturing I. Introduction to Process Development
10. Biopharmaceutical Manufacturing II. Up- stream Development
11. 12. Biopharmaceutical Manufacturing III. Downstream Development
12. 13. Biopharmaceutical Manufacturing IV. Pharma Development
13.

Lecture notes
Lecture notes and handouts will be provided electronically.

Autumn Semester 2015

W 3 credits
3V

6 credits
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques.

Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience.

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an introduction to the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and other imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes

Biomedical Imaging

New course. Not to be confused with 227-0385-00L of fall 2014.

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques.

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and other imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Biomedical Imaging

Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience.

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.


Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

Image Analysis and Computer Vision


Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as Camera, electronics and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites:

Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

Micro and Nano-Tomography of Biological Tissues

The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.
Objective  
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content  
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes  
Available online

Literature  
Will be indicated during the lecture.

Additionally recommended elective courses:

These courses are particularly recommended for the Bioimaging track. Please consult your track advisor if you wish to select other subjects.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0389-00L</td>
<td>Advanced Topics in Magnetic Resonance Imaging</td>
<td>Z</td>
<td>0</td>
<td>1V</td>
<td>K. P. Prüssmann</td>
<td>Available online</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is geared towards master and PhD students with a focus on bioimaging. It covers advanced topics in magnetic resonance imaging in biennial rotation, including the electromagnetics of MR signal detection, noise mechanisms, image reconstruction, radiofrequency pulse design, RF pulse trains, as well as advanced contrast mechanisms.</td>
<td>see above</td>
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</table>

| 227-0967-00L | Computational Neuroimaging Clinic  | W    | 3    | 2V    | K. E. Stephan         |                       |
| Abstract    | This seminar teaches problem solving skills for the design and analysis of neuroimaging data (IMRI, EEG). It deals with a wide variety of real-life problems that are brought to this meeting from the neuroimaging community at Zurich. Examples may include mass-univariate and multivariate analyses of IMRI data, dynamic causal modeling of IMRI and EEG data. 1. Consolidation of theoretical knowledge (obtained in the 'Methods & models for fMRI data analysis' lecture) in a practical setting. 2. Acquisition of practical problem solving strategies for computational modeling of neuroimaging and behavioural data. |                          |
| Objective   | This seminar teaches problem solving skills for the design and analysis of neuroimaging data (IMRI, EEG). It deals with a wide variety of real-life problems that are brought to this meeting from the neuroimaging community at Zurich. Examples may include mass-univariate and multivariate analyses of IMRI data, dynamic causal modeling of IMRI and EEG data. |                          |
| Content     | This seminar teaches problem solving skills for the design and analysis of neuroimaging data (IMRI, EEG). It deals with a wide variety of real-life problems that are brought to this meeting from the neuroimaging community at Zurich. Examples may include mass-univariate and multivariate analyses of IMRI data, dynamic causal modeling of IMRI and EEG data, or analyses of neuroimaging data on the basis of Bayesian models of behaviour. |                          |

| 227-0969-00L | Methods & Models for IMRI Data Analysis  | W    | 6    | 3V    | K. E. Stephan         |                       |
| Abstract    | This course teaches methods and models for IMRI data analysis, covering all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, statistical inference, multiple comparison corrections, event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. |                          |
| Objective   | To obtain in-depth knowledge of the theoretical foundations of SPM and DCM and of their application to empirical IMRI data. |                          |
| Content     | This course teaches state-of-the-art methods and models for IMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in psychiatry, neurology and neuroeconomics. |                          |

| 227-0971-00L | Computational Psychiatry  | W    | 2    | 2S    | K. E. Stephan         |                       |
| Abstract    | This four-day course teaches the toolkit for mastering challenges in computational psychiatry. It covers a variety of mathematical models for studying learning, decision-making or brain physiology in patients with psychiatric disorders. The course not only teaches the theory of computational modeling, but also demonstrate open source software in application to example data sets. |                          |
| Objective   | This course aims at bridging the gap between mathematical modelers and clinical neuroscientists by teaching computational techniques in the context of clinical applications. The hope is that the acquisition of a joint language and tool-kit will enable more effective communication and joint translational research between fields that are usually worlds apart. |                          |
| Content     | This four-day course teaches the toolkit for mastering challenges in computational psychiatry. It covers a variety of mathematical models for studying learning, decision-making or brain physiology in patients with psychiatric disorders. The course not only teaches the theory of computational modeling, but also demonstrate open source software in application to example data sets. |                          |

| 227-2037-00L | Physical Modelling and Simulation  | W    | 5    | 4G    | C. Hafner, J. Leuthold, J. Smajic |                       |
| Abstract    | Physical modelling plays an important role in the analysis and design of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied. |                          |
| Objective   | Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained. |                          |
Virtual Reality in Medicine

Since the fabrication and characterization of micro- and nanostructures is difficult, expensive, and time-consuming, numerical modelling drastically reduced the design process. Although many commercial software packages are available, it is important to know the drawbacks and difficulties of the numerical methods behind them and to be able to validate the results obtained with such packages. First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the problems to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electrodynamic to multi-physics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

151-0105-00L Quantitative Flow Visualization

**Abstract**
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

**Objective**
Understanding of hardware and software requirements and solutions. Fundamentals of optics, flow visualization and electronic image acquisition. Frequently used mage processing techniques (filtering, correlation processing, FFTs, color space transforms). Laser induced fluorescence. (Digital) Schlieren techniques, phase contrast imaging, interferometry, phase unwrapping. Wall shear and heat transfer measurements. Pattern recognition and feature extraction, proper orthogonal decomposition.

**Content**
- Fundamentals of optics, flow visualization and electronic image acquisition.
- Frequently used image processing techniques (filtering, correlation processing, FFTs, color space transforms).
- Laser induced fluorescence.
- (Digital) Schlieren techniques, phase contrast imaging, interferometry, phase unwrapping.
- Wall shear and heat transfer measurements.
- Pattern recognition and feature extraction, proper orthogonal decomposition.

**Prerequisites / notice**
Prerequisites: Fluidodynamics I, Numerical Mathematics, programming skills.
Language: German on request.

376-1279-00L Virtual Reality in Medicine

**Abstract**
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

**Objective**
Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

**Content**
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of highly-fidility sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

**Literature**

151-0605-00L Nanosystems

**Abstract**
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Special emphasis is placed on the emerging field of molecular electronic devices.

**Objective**
Familiarize students with basic science and engineering principles governing the nano domain. The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

**Content**
Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled.

**Literature**

This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based rendering techniques, covering topics such as lightfields and depth-image based rendering.

The programming assignments will be in C++. This will not be taught in the class.

Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

227-1033-00L Neuronomorphic Engineering I W 6 credits 2V+3U T. Delbrück, G. Indiveri, S.C. Liu

Abstract
This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective
Understanding of the characteristics of neuromorphic circuit elements. Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characteristics of neuromorphic circuits, from elementary devices to systems.

Literature
S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites / notice
Particular: The course is highly recommended for those who intend to take the spring semester course ‘Neuronomorphic Engineering II’, that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Abstract

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content

This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

465-0953-00L Biostatistics

Abstract

The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, analysis of variance, logistic regression, survival analysis (Kaplan-Meier curves and Cox-regression).

551-1295-00L Introduction to Bioinformatics: Concepts and Applications

Abstract

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Biology Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.</td>
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</tr>
<tr>
<td>Content</td>
<td>- The human body: nomenclature, axes, planes, orientations - Musculoskeletal system, Muscle contraction - Blood, Blood vessels - Immune system and lymphoid organs - Heart - Cardiovascular system - Respiratory system - Acid-Base-Homeostasis - Physical work</td>
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</thead>
<tbody>
<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>C. Frei</td>
</tr>
<tr>
<td>This course is part I of a two-semester course.</td>
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</tbody>
</table>
Abstract

The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

Objective

After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content

Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.

Lecture notes

Scripts of all lectures will be available.

Literature


227-0949-00L Biological Methods for Engineers (Basic Lab) ■ W 2 credits 4P C. Frei

Limited number of participants.

Abstract

The course during 4 afternoons covers basic laboratory skills and safety, cell culture, protein analysis, RNA/DNA Isolation and RT-PCR. Each topic will be introduced, followed by practical work at the bench. Presence during the course is mandatory.

Objective

The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Content

The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Prerequisites / notice

Enrollment is limited and given only to students in the Masters of Biomedical Engineering program.

>Biomechanics

Track Core Courses

During the Master program, a minimum of 12 CP must be obtained from track core courses.

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
</tbody>
</table>

Abstract

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content

- X-ray imaging
-Computed tomography
-Single photon emission tomography
-Positron emission tomography
-Magnetic resonance imaging
-Ultrasound/Doppler imaging

Lecture notes

Lecture notes and handouts

Literature

Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

227-0386-00L Biomedical Engineering  W 4 credits 3G J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong

Abstract

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content


Lecture notes

Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

227-0447-00L Image Analysis and Computer Vision  W 6 credits 3V+1U G. Székely, O. Gökel, L. Van Gool

Abstract


Objective

Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.

Lecture notes

Scripts of all lectures will be available.

Literature

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that can be input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information about multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

The course language is English.

227-0965-00L Micro and Nano-Tomography of Biological Tissues

Abstract
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Objective
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nanotomographic experiments.

This course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes
Available online

Literature
Will be indicated during the lecture.

376-1651-00L Clinical and Movement Biomechanics

Abstract
Measurement and modeling of the human movement during daily activities and in a clinical environment.

Objective
The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

Content
This course includes ethical considerations, measurement techniques, clinical testing, accessing movement data and anaysis as well as modeling with regards to human movement.

376-1985-00L Trauma Biomechanics

Abstract
Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

Objective
Introduction to the basic principles of trauma biomechanics.

Content
This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

Lecture notes
Available via homepage.

Literature

Recommended Elective Courses
These courses are particularly recommended for the Biomechanics track. Please consult your track advisor if you wish to select other subjects.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.</td>
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<tr>
<td>Content</td>
<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to biomechanical approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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<tr>
<td>Lecture notes</td>
<td>Script as well as additional material in the form of hand-outs will be distributed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Lecture notes and references therein.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>151-0511-00L</td>
<td>Mechanics of Nano- and Micro-Materials</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>C. Darako</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction to the mechanics of nano- and micro-materials and devices, in the quasistatic and dynamic domains. It reviews scale effects in materials, surveys available characterization techniques and describes the effects of surfaces and microscale contacts. Recent applications of nano- and micro-materials in engineering systems will be discussed.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Learn the fundamental mechanical properties of nano- and micro-system. Understand the effects of scales on the response of materials. Explore applications and devices exploiting the response of materials at small scales.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>follows soon</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Slides and notes from the course will be provided.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Relevant articles and reading materials will be provided. Various books will be recommended pertaining to the topics covered.</td>
<td></td>
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</tr>
</tbody>
</table>
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

The lecture will be taught in English.

Prerequisites / notice

151-0524-00L

Continuum Mechanics 1

Abstract
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

Objective
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

Content

Lecture notes
yes

151-0604-00L

Microrobotics

Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Lecture notes
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites / notice
The lecture will be taught in English.

151-0605-00L

Nanosystems

Abstract
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis is placed on the emerging field of molecular electronic devices.

Objective
Familiarize students with basic science and engineering principles governing the nano domain.

Content
The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Topics are treated in 2 blocks:
(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.

Literature

Prerequisites / notice
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

227-2037-00L

Physical Modelling and Simulation

Abstract
Physical modelling plays an important role in the analysis and design of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained.
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

## Objective

Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.

## Content

### I. THE FINITE ELEMENT METHOD

1. Introduction, model problems.
2. 1D problems. Piecewise polynomials in 1D.
3. 2D problems. Triangulations. Piecewise polynomials in 2D.
5. Implementation aspects.

### II. DIRECT SOLUTION METHODS

6. LU and Cholesky decomposition.
7. Sparse matrices.

### III. ITERATIVE SOLUTION METHODS

9. Stationary iterative methods, preconditioning.
11. Incomplete factorization preconditioning.
12. Multigrid preconditioning.
13. Nonsymmetric problems (GMRES, BiCGstab).

## Literature


## Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science. The exercises are made with Matlab.

## 376-1103-00L

### Abstract

Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

### Objective

Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nanochemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

### Content

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.
All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

376-1219-00L  Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions

W  3 credits  2V  R. Riener, R. Gassert, L. Marchal Crespo

Abstract
Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

Content
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal

Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient

J. Werner, Oldenbourg Wissenschaftsverlag 2005.


Selected Journal Articles and Web Links:


VideoTact, ForeThought Development, LLC. http://my.execpc.com/~dwysocki/videotac.html

Prerequisites / notice

Target Group: Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome

376-1279-00L Virtual Reality in Medicine W 3 credits 2V R. Riener, M. Harders

Abstract Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

Content Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group: Students of higher semesters and PhD students of
- D-HEST, D-MAVT, D-ITET, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome!

Prerequisites / notice
The course language is English.
Basic experience in Information Technology and Computer Science will be of advantage
More details will be announced in the lecture.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>G</th>
<th>L. Delamarche</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>K. Maniura, J. Möller, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an artificially produced material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts provided during the classes and references therein.

<table>
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<tr>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>376-1351-00L</td>
<td>Micro/Nanotechnology and Microfluidics for Biomedical Applications</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>E. Delamarche</td>
</tr>
</tbody>
</table>

Abstract
This course is an introduction to techniques in micro/nanotechnology and to microfluidics. It reviews how many familiar devices are built and can be used for research and biomedical applications. Transistors for DNA sequencing, bearers for patterning proteins, hard-disk technology for biosensing and scanning microfluidics for analyzing tissue sections are just a few examples of the covered topics.

Objective
The main objective of the course is to introduce micro/nanotechnology and microfluidics to students having a background in the life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how micro/nanotechnology pervades throughout life sciences. Microfluidics will be emphasized due to their increasing importance in research and medical applications. The second objective is to have life students less intimidated by micro/nanotechnology and make them able to link instruments and techniques to specific problems that they might have in their projects/studies. This will also help students getting access to the ETHZ/IBM Nanotech Center infrastructure if needed.

Content
Mostly formal lectures (2 x 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).

Literature
Lectures can be accessed online.

<table>
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<tr>
<th>Code</th>
<th>Title</th>
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<th>Credits</th>
<th>G</th>
<th>L. Delamarche</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1720-00L</td>
<td>Application of MATLAB in the Human Movement Sciences</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>R. van de Langenberg</td>
</tr>
</tbody>
</table>

Abstract
Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).

Objective
Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromygographical data using the MATLAB computing environment.

Content
Drawbacks of Excel: Possibilities in MATLAB; Import of several data formats: Plot of one and more signals; Removing of an offset and filtering of data based on self-written functions; Normalisation and parametrisation of data; Reliability: Interpolation, Differentiation and Integration in MATLAB.

Literature
During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.

Prerequisites / notice
A laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

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<tr>
<th>Code</th>
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<th>Credits</th>
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<th>L. Delamarche</th>
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</thead>
<tbody>
<tr>
<td>376-1974-00L</td>
<td>Colloquium in Biomechanics</td>
<td>W</td>
<td>2 credits</td>
<td>2K</td>
<td>B. Helgason, S. J. Ferguson, R. Müller, J. G. Niederer, B. Taylor, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

Abstract
Current topics in biomechanics presented by speakers from academia and industry.

Objective
Getting insight into actual areas and problems of biomechanics.

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<tr>
<th>Code</th>
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<th>L. Delamarche</th>
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</thead>
<tbody>
<tr>
<td>376-2017-00L</td>
<td>Biomechanics of Sports Injuries and Rehabilitation</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>K.U. Schmitt, J. Goldhahn</td>
</tr>
</tbody>
</table>

Abstract
This lecture introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries.

Objective
Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

Content
This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

Lecture notes
Handouts can be downloaded.

<table>
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<tr>
<th>Code</th>
<th>Title</th>
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<th>Credits</th>
<th>G</th>
<th>L. Delamarche</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0341-00L</td>
<td>Medical Physics I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>P. Manser</td>
</tr>
</tbody>
</table>

Abstract
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Objective
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

A script will be provided.
Medical Physics

Track Core Courses

During the master program, a minimum of 12 CP must be obtained from track core courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0385-00L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozierke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>227-0399-10L</td>
<td>Medical Physics I</td>
<td>W</td>
<td>6</td>
<td>2G</td>
<td>P. Manser</td>
</tr>
<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>C. Frei</td>
</tr>
<tr>
<td>227-0949-00L</td>
<td>Biological Methods for Engineers (Basic Lab)</td>
<td>W</td>
<td>2</td>
<td>4P</td>
<td>C. Frei</td>
</tr>
</tbody>
</table>

Abstract

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective

To understand the basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.

Content

- The human body: nomenclature, axes, planes, orientations
- Musculoskeletal system, Muscle contraction
- Blood, Blood vessels
- Immune system and lymphoid organs
- Heart
- Cardiovascular system
- Respiratory system
- Acid-Base-Homeostasis
- Physical work

Lecture notes

Lecture notes and handouts

Literature

Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008
Faller A., Schuenke M. The Human Body; Thieme 2004
Nette F. Atlas of human anatomy; Elsevier 2014
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

A script will be provided.

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### Recommended Elective Courses

These courses are particularly recommended for the Medical Physics track. Please consult your track advisor if you wish to select other subjects.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0574-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>B. K. R. Müller</td>
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</tbody>
</table>

The former number of this course unit is 465-0951-00L.
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxido and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

### Other Elective Courses

#### Lecture notes

Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice

Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

The course language is English.

### Biology Courses

#### Lecture notes

Lecture notes and handouts

#### Literature

Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008
Faller A., Schuenke M. The Human Body; Thieme 2004
Netter F. Atlas of Human Anatomy; Elsevier 2014

#### Cell and Molecular Biology for Engineers I

This course is part I of a two-semester course.
Abstract
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

Objective
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content
Lectures will cover the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.

Lecture notes
Scripts of all lectures will be available.

Literature

Molecular Bioengineering
Track Core Courses
During the Master program, a minimum of 12 CP must be obtained from track core courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1103-00L</td>
<td>Frontiers in Nanotechnology</td>
<td>W</td>
<td>4</td>
<td>4V</td>
<td>V. Vogel, further lecturers</td>
</tr>
</tbody>
</table>

Abstract
Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

Objective
Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Content
Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Lecture notes
All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>K. Maniura, J. Möller, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts can be accessed online.

Literature
(available online via ETH library)

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>B. K. R. Müller</td>
</tr>
</tbody>
</table>

Abstract
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission.

**Lectures**

Biomedical Imaging will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

**Objective**

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.

**Prerequisites / notice**

These courses are particularly recommended for the Molecular Bioengineering track. Please consult your track advisor if you wish to select other subjects.

**Number**

<table>
<thead>
<tr>
<th>151-0504-00L</th>
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<tbody>
<tr>
<td>227-0385-10L</td>
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<tr>
<td>227-0386-00L</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0504-00L</td>
<td>Microrobots</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Várös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

**Abstract**

Microrobots is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

The objective of this course is to expose students to the fundamental aspects of the emerging field of micro robotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

**Content**

- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Lecture notes**

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

The lecture will be taught in English.

**Literature**

- Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011
- Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

**Prerequisites / notice**

- New course. Not to be confused with 227-0385-00L of fall 2014.
- Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Objective


Abstract

Practical and theoretical exercises in small groups in the laboratory.

Content

Micro and Nano-Tomography of Biological Tissues

The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Objective

Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content

Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes

Available online

Literature

Will be indicated during the lecture.

327-0965-00L

Micro and Nano-Tomography of Biological Tissues

W 4 credits 3G M. Stampanoni, K. S. Mader


https://www1.ethz.ch/lbb/Education/BME

227-0965-00L

Micro and Nano-Tomography of Biological Tissues

W 4 credits 3G M. Stampanoni, K. S. Mader

https://www1.ethz.ch/lbb/Education/BME

327-0505-00L

Surfaces, Interfaces and their Applications I

W 3 credits 2V+1U N. Spencer, M. P. Heuberger, L. Isa

Introduction to Corrosion Science

Practical and theoretical exercises in small groups in the laboratory.

327-1101-00L

Biominerlization

W 2 credits 2V K.H. Ernst

The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biominerlization.

The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.
Content

Biomineralization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biomineralization (BM) / types of biominerals and their function / crystal nucleation and growth / biological induction of BM / control of crystal morphology, habit, shape and orientation by organisms / strategies of compartmentalization / the interface between biomolecules (peptides, polysaccharides) and the mineral phases / modern experimental methods for studying BM / phenomena / inter-, intra, extra- and epidermal BM / organic templates and matrices for BM / structure of bone, teeth (vertebrates and invertebrates) and mollusk shells / calcification / siliification in diatoms, radiolarians and plants / calcium and iron storage / impact of BM on lithosphere and atmosphere / evolution / taxonomy of organisms.

1. Introduction and overview
2. Biominerals and their functions
3. Chemical control of biomineralization
4. Control of morphology: Organic templates and additives
5. Modern methods of investigation of BM
6. BM in matrices: bone and nacre
7. Vertebrate teeth
8. Invertebrate teeth
9. BM within vesicles: calcite of coccoliths
10. Silica
11. Iron storage and mineralization

Lecture notes
Script with more than 600 pages with many illustrations will be distributed free of charge.

Literature

3) P. M. Dove, J. J. DeYoreo, S. Weiner (Eds.) Biominalization, Reviews in Mineralogy & Geochemistry Vol. 54, 2003

Prerequisites / notice
Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer.

402-0341-00L Medical Physics I

Abstract

Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

Content

The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be described. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Lecture notes
A script will be provided.

535-0423-00L Drug Delivery and Drug Targeting

Abstract

The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

Objective

The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

Content

The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Lecture notes
Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using http://www.galenik.ethz.ch/teaching/drug_del_drug targ

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galeniche Pharmazie II (Galeniche Pharmacy II).

Literature


Further references will be provided in the course.

636-0507-00L Synthetic Biology II

Abstract

7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content

Presentations on advanced synthetic biology topics (e.g. genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis, project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Data: 06.12.2018 13:04
Autumn Semester 2015 Page 272 of 1432
The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

### Other Elective Courses

These courses may be suitable for the Molecular Bioengineering track. Please consult your track advisor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer</td>
</tr>
</tbody>
</table>

**Abstract**
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Objective**
This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Content**
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Lecture notes**
Updated handouts will be provided during the class.

**Literature**
Current literature references will be provided during the lectures.

**Prerequisites / notice**
English

The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, T. J. Erb, J. Piel</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

**Objective**
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.

**Content**
Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

**List of topics:**
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaerobic provocation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

**Lecture notes**
A script will be provided during the course.

### Biology Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
</tbody>
</table>

**Abstract**
This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.

**Objective**
To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.

**Content**
- The human body: nomenclature, axes, planes, orientations
- Musculoskeletal system, Muscle contraction
- Blood, Blood vessels
- Immune system and lymphoid organs
- Heart
- Cardiovascular system
- Respiratory system
- Acid-Base-Homeostasis
- Physical work

**Lecture notes**
Lecture notes and handouts

**Literature**
Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008
Faller A., Schuenke M. The Human Body; Thieme 2004
Netter F. Atlas of human anatomy; Elsevier 2014

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<th>Number</th>
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<th>Hours</th>
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<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>C. Frei</td>
</tr>
</tbody>
</table>

**Abstract**
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

**Objective**
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.
Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.

**Semester Project**

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences (Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST))</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
<tr>
<td></td>
<td>* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the-Art, the &quot;in this paper&quot; paragraph, the scientific part, the summary, Equations, Figures).</td>
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<td>* Topic 2: Power Point Presentations.</td>
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<td></td>
<td>* Topic 3: Citation Rules and Citation Software.</td>
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<td></td>
<td>* Topic 4: Guidelines for Research Integrity.</td>
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<tr>
<td></td>
<td>ETH &quot;Citation Etiquette&quot;, see <a href="http://www.plagiate.ethz.ch">www.plagiate.ethz.ch</a>.</td>
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<tr>
<td></td>
<td>Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.</td>
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**Master Thesis**

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<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences (Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST))</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
<tr>
<td></td>
<td>* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the-Art, the &quot;in this paper&quot; paragraph, the scientific part, the summary, Equations, Figures).</td>
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<td></td>
<td>* Topic 2: Power Point Presentations.</td>
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<td></td>
<td>* Topic 3: Citation Rules and Citation Software.</td>
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<td></td>
<td>* Topic 4: Guidelines for Research Integrity.</td>
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<tr>
<td></td>
<td>ETH &quot;Citation Etiquette&quot;, see <a href="http://www.plagiate.ethz.ch">www.plagiate.ethz.ch</a>.</td>
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<tr>
<td></td>
<td>Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.</td>
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</tbody>
</table>
Admission only if all of the following apply:

a. bachelor program successfully completed;

b. successfully completion of the track core courses, the biology laboratory and the semester project;

c. acquired (if applicable) all credits from additional requirements for admission to master program.

Registration in mystudies required!

Abstract

The masters program culminates in a six months research project which addresses a scientific research questions on one's chosen area of specialization. The masters thesis is supervised by a program-affiliated faculty member and the topic must be approved by the track advisor.

Objective

see above

**Compulsory Electives in Humanities, Social and Political Sciences**

Recommended GESS compulsory elective courses (Type B) for D-ITET.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

**Generally Accessible Seminars and Colloquia**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0970-00L</td>
<td>Research Topics in Biomedical Engineering</td>
<td>Z</td>
<td>0</td>
<td>2K</td>
<td>M. Rudin, S. Kozerke, K. P. Prüssmann, M. Stampanoni, K. E. Stephan, J. Vörös</td>
</tr>
</tbody>
</table>

Abstract

Current topics in Biomedical Engineering presented by speakers from academia and industry.

Objective

Getting insight into actual areas and problems of Biomedical Engineering an Health Care.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>Z</td>
<td>0</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
</tr>
</tbody>
</table>

Abstract

Actuel developments and problems of magnetic resonance imaging (MRI)

Objective

Getting insight to advanced topics in Magnetic Resonance Imaging

**Biomedical Engineering Master - Key for Type**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>Eligibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E- Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr Suitable for doctorate</td>
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**Key for Hours**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
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<td>practical/laboratory course</td>
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<td>independent project</td>
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<td>R</td>
<td>revision course / private study</td>
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</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Biotechnology Bachelor

### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>626-0002-00L</td>
<td>Bioinformatics</td>
<td>W+</td>
<td>6</td>
<td>3G</td>
<td>J. Stelling, N. Beeremwinkel</td>
</tr>
</tbody>
</table>

**Abstract**
The course introduces concepts of bioinformatics starting from first principles: DNA sequence alignment, phylogenetic tree inference, genome annotation, protein structure and function prediction. Key methods and algorithms are covered, including dynamic programming, Markov and Hidden Markov models, and molecular dynamics simulations. Practical applications and limitations are discussed.

**Objective**
The course aims at introducing the fundamental concepts and methods of bioinformatics. Emphasis is given to a deep understanding of the methods’ foundations and limitations to enable critical evaluations and applications of bioinformatics tools in areas such as biotechnology and systems biology.

**Content**
Lecture topics: (1) Background: DNA, proteins, databases; (2-4) Sequence alignments, dynamic programming; (5-7) Evolutionary processes, Markov models, phylogenetic trees; (8-9) Genome characteristics, Hidden Markov models, genome annotation; (10-12) Protein structure and function, molecular modeling; (13) Outlook: genomics and proteomics.

**Lecture notes**
Course material will be made available at: http://www.csb.ethz.ch

**Literature**
M. Zvelebil & J.O. Baum, Understanding bioinformatics, Garland Science Textbooks, 2007

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>626-0005-00L</td>
<td>Mathematical Modelling in Systems Biology</td>
<td>W+</td>
<td>6</td>
<td>3G</td>
<td>D. Iber</td>
</tr>
</tbody>
</table>

**Abstract**
Basic concepts and mathematical tools to explore biochemical reaction kinetics and biological network dynamics.

**Objective**
The aim of the course is to provide an introductory overview of mathematical and computational methods to analyse biological network dynamics.

**Content**
1. Introduction to Mathematical Modeling
2. Introduction to Biochemical Reaction Modeling
3. Model Analysis: Phase Plane
4. Model Analysis: Linear Stability Analysis
5. Model Analysis: Bifurcation Analysis
6. Regulatory Feedback: Switches
7. Regulatory Feedback: Adaptation
8. Regulatory Feedback: Oscillations and Delay Equations
9. Receptor Signaling and Signaling Cascades
10. Network Properties: Sensitivity and Robustness
11. Introduction to Parameter Estimation

**Literature**
- Keener and Sneyd, Mathematical Physiology, Springer
- Klipp et al, Systems Biology in Practice, Wiley
- Kreyszig, Engineering Mathematics, Wiley

**Prerequisites / notice**
Introductory courses in Mathematics (Linear Algebra, Differential Equations, Numerics) and basic concepts of programming.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>626-0007-00L</td>
<td>Microbial Biotechnology</td>
<td>W+</td>
<td>6</td>
<td>3V</td>
<td>S. Panke</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction into the field of microbial biotechnology, covering possible products, fermentation and downstream technology.

**Objective**
The student should be able to identify opportunities for microbial bioprocesses and to go through basic and advanced design procedures for microbial bioprocesses.

**Content**
Students will obtain a thorough overview over microbial biotech products and the elements of bioprocess design: cellular growth and its modelling; mass transfer in fermentation; bioreaction engineering; bioreactors; downstream processing

**Lecture notes**
Handout in class

**Literature**
- Nielsen/Villadsen, Bioreaction Engineering Principles (Kluwer)
- van’t Riet/Tramper: Basic bioreactor design
- Stephanopoulos/Aristidou/Nielsen: Metabolic Engineering

**Prerequisites / notice**
Prerequisites: Fundamentals in Chemistry and Biology (eg Bio-Engineering 151-0600-00)

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>626-0001-00L</td>
<td>Microtechnology and Microelectronics</td>
<td>W+</td>
<td>6</td>
<td>3G</td>
<td>A. Hierlemann</td>
</tr>
</tbody>
</table>

**Abstract**
Students are introduced to the basics of semiconductors, microelectronics, microtechnology, and silicon process technology. They will get to know the fabrication of silicon-based microdevices and -systems by a sequence of defined batch processing steps as well as dedicated microfabrication processes.

**Objective**
Students are introduced to the basics of semiconductors, microelectronics, microtechnology, and silicon process technology. They will get to know the different fabrication methods for various microdevices and systems.

**Content**
Fundamentals of semiconductors
- Basics of microelectronics: transistor and diode.
- Silicon processing and fabrication steps
- Silicon crystal structure and manufacturing
- Thermal oxidation
- Doping via diffusion and ion implantation
- Photolithography
- Thin film deposition: dielectrics and metals
- Wet etching & bulk micromachining
- Dry etching & surface micromachining
- Microelectronics processing and fabrication sequence
- Packaging

**Lecture notes**
Handouts in English
### Molecular Biology

**Abstract**
This lecture course gives an in-depth view into molecular mechanisms controlling basic biological processes, ranging from genetic regulatory networks, the internal functional organization of a cell to the signaling events controlling cells in their social context. In the tutorials methods and techniques used in molecular biology to solve problems in biotechnology and medicine are reviewed.

**Objective**
The goal is to achieve a high level knowledge of basic biological processes, to learn the methodology to tackle questions in molecular biology and to interpret experimental molecular data. Emphasis is given to cellular processes amenable to studies in systems and synthetic biology.

**Content**
The molecular biology of basic biological processes of a cell will be presented from the inside-out; in the nucleus the structure and function of the genetic material will be introduced, the compartmentalization of the cytoplasm and its ensuing specialization will be presented and the physiological activities of cellular populations through their signaling and interactions will be analyzed.

The course will be emphasize the logic of experimental design, the application of relevant methodology and equipment and of data analysis.

The following chapters will be discussed:

1. Chromosomes and Genomes
2. Control of gene expression
3. From gene sequence to biopharmaceuticals
4. Membrane structure and function
5. Intracellular compartments and protein sorting
6. Mechanisms of cell communication
7. The cytoskeleton, cell junctions and extracellular matrix
8. Cell cycle control
9. Development and apoptosis
10. Cancer
11. Tissue renewal and stem cells
12. Project planning and implementation

The tutorials are focused on state-of-the-art methods and techniques of molecular biology. Students are trained how to prepare an oral scientific presentation.

**Lecture notes**
The Powerpoint presentations of the lectures as well as other course material relevant for an active participation will be made available online.

**Literature**

### Interdisciplinary Biotechnology

**Abstract**
Interdisciplinary Biotechnology Seminar

**Objective**
To provide a common frame of reference for all novel biotechnology students who have come to Basel.

**Content**
An overview of the scope of the 3rd year Biotechnology BSc.

**Lecture notes**
Hands out during the course.

**Prerequisites / notice**
Block course (Tuesday afternoon to Friday evening) at the beginning of the fall semester.

**Literature**
- Interdisciplinary Biotechnology Seminar

### Nanomachines of the Cell (Part I): Principles

**Abstract**
Molecular biotechnology students will combine basic knowledge in molecular cell biology, biochemistry, proteomics, biophysics, bioinformatics, bionanotechnology and engineering to learn how the nanomachines of the cell works and to use this knowledge to address future molecular biotechnological and bionanotechnological questions. Particularly it will be addressed how biomolecular units can be characterized as working elements and or subunits in molecular biotechnological and bionanotechnological fields.

**Objective**
Gain of an interdisciplinary research and development competence, which qualifies for scientific work (master's or doctoral thesis) as well as for work in the research and development department of a biotechnological company. The module is of general use in nano- and biotechnological courses of study focusing modern biomolecular technologies.
6 credits

1- What is light: Waves and photons (Electromagnetism, Maxwells equations, waves)

[...]

6 credits

Prerequisites / notice

The module is composed of 3 SWS (3 hours/week); 2-hour lecture, 1-hour seminar. For the seminar, students prepare oral presentations on specific in-depth subjects with the guidance of the lecturer.

Lecture notes

Hand out will be given to students at lecture.

Content

- Introduce the basics of fluidics, covering the principles of fluid dynamics and the behavior of fluids.
- Discuss various applications of fluidics in different fields such as biology, medicine, and engineering.
- Cover the practical aspects of designing and operating fluidic systems.
- Explore the integration of microfluidics in high-throughput screening.

Literature

- *Micromachines in Biology and Medicine* by T.A. van der Ven
- *Microfluidics in Bioanalysis* by C. van den Engh
- *Microfluidics and Lab-on-a-Chip Technology* by T. Tennekes

Prerequisites / notice

Students are expected to be competent with calculus, and familiar with differential equations. Basic Physics knowledge is necessary.

Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>626-0501-00L</td>
<td>Analytical Chemistry I: Structure Determination</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>external organisers</td>
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<tr>
<td>626-0503-00L</td>
<td>Biological Chemistry, Metabolism</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>external organisers</td>
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<tr>
<td>626-0505-00L</td>
<td>Macromolecules, Basics in Genetic and Gene-Expressions</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>external organisers</td>
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<tr>
<td>626-0509-00L</td>
<td>Introduction to Nano Sciences</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>external organisers</td>
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<tr>
<td>626-0511-00L</td>
<td>Programming I</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>external organisers</td>
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</table>
Abstract

Content

<table>
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<tr>
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<th>Type</th>
<th>Credits</th>
<th>Semester</th>
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<tbody>
<tr>
<td>626-0513-00L</td>
<td>Scientific Calculation</td>
<td>W</td>
<td>6</td>
<td>3G</td>
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<tr>
<td>626-0011-00L</td>
<td>Linear Algebra with Applications to Systems Biology</td>
<td>W+</td>
<td>6</td>
<td>3G</td>
</tr>
</tbody>
</table>

Abstract
The course presents concepts and tools from linear algebra and linear programming together with applications to systems biology. The course builds on freshman courses Mathematical Foundations: Mathematical Analysis I and II.

Objective
To give the student a solid background in the theory and applications of linear algebra and linear programming with particular emphasis and motivating examples from systems biology.

Content
Matrices and inverses; LU factorization; subspaces; null space; independence; basis; dimension; rank; orthogonality and projections; eigenvalues and eigenvectors; diagonalization; positive definite matrices; SVD; linear programs; application to metabolic reaction networks will be integrated throughout the course.

Literature
Introduction to Linear Algebra, Fourth Edition, William Strang
Linear and nonlinear programming, David Leunberger

Laboratory Courses
The laboratory courses will be offered in spring semester only.

Compulsory Electives in Humanities, Social and Political Sciences
The Compulsory Electives in Humanities, Social and Political Sciences can be attended at the University of Basel (Faculty of Humanities as well as Faculty of Business and Economics) and/or at the University of Zürich.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Biotechnology Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Eligible for credits</th>
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<tbody>
<tr>
<td>O</td>
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<td>E-</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
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Key for Hours

<table>
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<th>Type</th>
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<td>lecture with exercise</td>
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<td>S</td>
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<td>practical/laboratory course</td>
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<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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ECTS
European Credit Transfer and Accumulation System

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Biotechnology Master

**Majors**

<table>
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<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>636-0001-00L</td>
<td>Separations in Biotechnology and Bioprocess Economy</td>
<td>W+</td>
<td>6</td>
<td>3G</td>
<td>S. Panke</td>
</tr>
</tbody>
</table>

**Abstract**
Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separations processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

**Objective**
Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

**Content**
Introduction membrane operations adsorption and chromatography crystallization overall process economics

**Lecture notes**
Handouts during course

<table>
<thead>
<tr>
<th>Number</th>
<th>Biological Engineering and Biotechnology</th>
<th>W+</th>
<th>6</th>
<th>3V</th>
<th>M. Fussenegger</th>
</tr>
</thead>
</table>

**Abstract**
Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

**Objective**

**Lecture notes**
Handouts during the course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Systems Biology</th>
<th>W+</th>
<th>6</th>
<th>3G</th>
<th>R. Paro, N. Beerenwinkel</th>
</tr>
</thead>
</table>

**Abstract**
This lecture course is an introduction to systems biology. It explores how complex biological networks are experimentally studied and how the resulting data is mathematically evaluated in order to derive predictive models. The biology of selected cellular processes, ranging from protein interaction networks to gene controlling systems and signaling cascades will be discussed in detail.

**Objective**
The goal of this course is to learn how a detailed quantitative description of complex biological processes can be employed for a better understanding of molecular interactions, the power and efficiency of regulatory networks, and the evolution of biological complexity. Students will learn how to identify techniques producing quantitative data and how to develop statistical models and efficient statistical inference algorithms to recognize patterns, molecular interrelationships and systems behavior.

**Content**
Sessions will alternate between a thorough introduction into the basic biology of defined cellular processes and a corresponding mathematical and statistical analysis of the experimental data. Selected complex biological systems and the respective experimental tools for a quantitative analysis will be presented. Examples include the identification of protein interaction networks required for specific physiological processes in yeast based on graph theoretic methods, including the identification of network motifs and the global statistical analysis of graph properties (power laws); the comparative analysis of gene expressions data from cancer and normal cells involving data normalization techniques, multiple testing procedures, clustering algorithms, Bayesian networks, and linear dynamical systems; the definition of hierarchies of kinase signaling cascades employing Bayesian networks and their causal interpretation and nested effects models for the analysis of perturbed systems; analysis of deep sequencing data derived from studies of chromatin control and gene expression.

**Topics**

**Lecture notes**
The Powerpoint presentations of the lectures as well as other course material relevant for an active participation will be made available online.

**Literature**

<table>
<thead>
<tr>
<th>Number</th>
<th>Introduction to Biological Computers</th>
<th>W+</th>
<th>6</th>
<th>3G</th>
<th>Y. Benenson</th>
</tr>
</thead>
</table>

**Prerequisites:** Synthetic Biology I (636-0002-00 L). Basic knowledge of molecular biology is assumed.
Abstract
Biological computers are man-made biological networks that interrogate and control biological hosts-cells and organisms-in which they operate. Their key features, inspired by computer science, are programmability, modularity and versatility. The course will show how to rationally design, implement and test biological computers using molecular engineering, DNA nanotechnology and synthetic biology.

Objective
The course has the following objectives:

- Familiarize students with parallels between theories in computer science and engineering and information-processing in live cells and organisms
- Introduce basic theories of computation
- Introduce approaches to creating novel biological computing systems in non-living environment and in living cells including bacteria, yeast and mammalian/human cells.

The covered approaches will include:
- Nucleic acids engineering
- DNA and RNA nanotechnology
- Synthetic biology and gene circuit engineering
- High-throughput genome engineering and gene circuit assembly

- Equip the students with computer-aided design (CAD) tools for biocomputing circuit engineering. A number of tutorials will introduce MATLAB SimBiology toolbox for circuit design and simulations

- Foster creativity, research and communication skills through semester-long "Design challenge" assignment in the broad field of biological computing and biological circuit engineering.
Note: the exact subjects can change, the details below should only serve for general orientation

Lecture 1. Introduction: what is molecular computation (part I)?
* What is computing in general?
* What is computing in the biological context (examples from development, chemotaxis and gene regulation)
* The difference between natural computing and engineered biocomputing systems

Lecture 2: What is molecular computation (part II) + State machines
1st hour
* Detailed definition of an engineered biocomputing system
* Basics of characterization
* Design challenge presentation

2nd hour
* Theories of computation: state machines (finite automata and Turing machines)

Lecture 3: Additional models of computation
* Logic circuits
* Analog circuits
* RAM machines

Basic approaches to computer science notions relevant to molecular computation. (i) State machines; (ii) Boolean networks; (iii) analog computing; (iv) distributed computing. Design Challenge presentation.

Lecture 4. Classical DNA computing
* Adleman experiment
* Maximal clique problem
* SAT problem

Lecture 5: Molecular State machines through self-assembly
* Tiling implementation of state machine
* DNA-based tiling system
* DNA/RNA origami as a spin-off of self-assembling state machines

Lecture 6: Molecular State machines that use DNA-encoded tapes
* Early theoretical work
* Tape extension system
* DNA and enzyme-based finite automata for diagnostic applications

Lecture 7: Introduction to cell-based logic and analog circuits
* Computing with (bio)chemical reaction networks
* Turing computation with ultrasensitivity and cooperativity
* Specific examples

Lecture 8: Transcriptional circuits I
* Introducing transcription-based circuits
* General features and considerations
* Guidelines for large circuit construction

Lecture 9: Transcriptional circuits II
* Large-scale distributed logic circuits in bacteria
* Toward large-scale circuits in mammalian cells

Lecture 10: RNA circuits I
* General principles of RNA-centered circuit design
* Riboswitches and sRNA regulation in bacteria
* Riboswitches in yeast and mammalian cells
* General approach to RNAi-based computing

Lecture 11: RNA circuits II
* RNAi logic circuits
* RNAi-based cell type classifiers
* Hybrid transcriptional/posttranscriptional approaches

Lecture 12: In vitro DNA-based logic circuits
* DNAzyme circuits playing tic-tac-toe against human opponents
* DNA brain

Lecture 13: Advanced topics
* Engineered cellular memory
* Counting and sequential logic
* The role of evolution
* Fail-safe design principles
Lecture notes will be available online

As a way of general introduction, the following two review papers could be useful:


Benenson, Y. Biocomputers: from test tubes to live cells. Molecular Biosystems 2009, 5:675:685

Compulsory attendance of (at least) 12 of 14 lectures. In addition, it is recommended that students take 636-0002-00 Synthetic Biology I prior to attending this course. Basic knowledge of molecular biology is assumed.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0013-00L</td>
<td>Data Mining</td>
<td>6</td>
<td>3G</td>
<td>K. M. Borgwardt</td>
</tr>
</tbody>
</table>

Abstract

Data Mining, the search for statistical dependencies in large databases, is of utmost importance in modern society, in particular in biological and medical research. This course provides an introduction to the key problems, concepts, and algorithms in data mining, and the applications of data mining in computational biology.

Objective

The goal of this course is that the participants gain an understanding of data mining problems and algorithms to solve these problems, in particular in biological and medical applications.

Content

The goal of this course is to find patterns and statistical dependencies in large databases, to gain an understanding of the underlying system from which the data were obtained. In computational biology, data mining contributes to the analysis of vast experimental data generated by high-throughput technologies, and thereby enables the generation of new hypotheses.

In this course, we will present the algorithmic foundations of data mining and its applications in computational biology. The course will feature an introduction to popular data mining problems and algorithms, reaching from classification to clustering. Based on these techniques, we will examine how these algorithms can be used to study gene expression, protein function or the structure of biological networks. This course is intended for both students who are interested in applying data mining algorithms and students who would like to gain an understanding of the key algorithmic concepts in data mining.

Tentative list of topics:

1. Classification
2. Clustering
3. Feature Selection
4. Text Mining
5. Association Rule Mining
6. Transductive Learning
7. Graph Mining

Course material will be provided in form of slides.

Will be provided during the course.

Basic understanding of mathematics, as taught in basic mathematics courses at the Bachelor's level.

The MSc Electives will be held in Zürich or Basel

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0927-00L</td>
<td>Rate-Controlled Separations in Fine Chemistry</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Mazzotti</td>
</tr>
</tbody>
</table>

Abstract

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Objective

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content

The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Handouts during the class
### 363-0389-00L Technology and Innovation Management

**Abstract**
This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.

**Objective**
This course intends to enable all students to:
- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation

**Content**
This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success is small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

**Lecture notes**
Slides will be available on the TIMGROUP website.

**Prerequisites / notice**
Readings will be available on the TIMGROUP website.

**Literature**
No specific background in economics or management is required.

### 376-1714-00L Biocompatible Materials

**Abstract**
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

**Objective**
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

**Content**
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced.

Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Lecture notes**
Handouts can be accessed online.

**Literature**

(available online via ETH library)

Handouts provided during the classes and references therein.

### 529-0733-00L Enzymes

**Abstract**
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

**Objective**
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

**Content**
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

**Lecture notes**
A script will not be handed out.

**Literature**

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

### 529-0837-00L Biomicrofluidic Engineering

**Abstract**
Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

**Objective**
In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis.

A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale.

The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.
## Content

Specific topics in the course include, but not limited to:

1. Theoretical Concepts
   - Features of mass and thermal transport on the microscale
   - Key scaling laws
2. Microfluidic Device Manufacture
3. Conventional lithographic processing of rigid materials
4. Soft lithographic processing of plastics and polymers
5. Mass fabrication of polymeric devices
6. Unit operations and functional components
7. Analytical separations (electrophoresis and chromatography)
8. Chemical and biological synthesis
9. Sample pretreatment (filtration, SPE, pre-concentration)
10. Molecular detection

## Lecture notes

Lecture handouts, background literature, problem sheets and notes will be provided electronically.

### 535-0030-00L Therapeutic Proteins

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>3G</th>
<th>C. Halin Winter, D. Neri</th>
</tr>
</thead>
</table>

**Abstract**

In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.

**Objective**

Students know and understand:

- basic mechanisms and regulation of the immune response
- the pathogenic mechanisms of the most important immune-mediated disorders
- the most frequently used expression systems for the production of therapeutic proteins
- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

**Content**

The course consists of two parts:

In a first part, students will complete their training in pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases, the use of protein-engineering approaches, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

**Literature**

- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

### 535-0423-00L Drug Delivery and Drug Targeting

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>J.C. Leroux, D. Brambilla</th>
</tr>
</thead>
</table>

**Abstract**

The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

**Objective**

The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

**Content**

The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).

**Literature**


Further references will be provided in the course.

### 551-1105-00L Glycobiology

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>2V</th>
<th>M. Aebi, T. Hennet</th>
</tr>
</thead>
</table>

**Abstract**

Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

**Objective**

- Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

**Content**

- Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

**Lecture notes**

- handouts

**Literature**

- Prerequisites / notice

The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.
Evolutionary dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.

Evolution is the one theory that encompasses all of biology. It provides a single, unifying concept to understand the living systems that we observe today. We will introduce several types of mathematical models of evolution to describe gene frequency changes over time in the context of different biological systems, focusing on asexual populations. Viruses and cancer cells provide the most prominent examples of such systems and they are at the same time of great biomedical interest. The course will cover some classical mathematical population genetics and population dynamics, and also introduce several new approaches. This is reflected in a diverse set of mathematical concepts which make their appearance throughout the course, all of which are introduced from scratch. Topics covered include the quasispecies equation, evolution of HIV, evolutionary game theory, birth-death processes, evolutionary stability, evolutionary graph theory, somatic evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease. Axioms for the mathematical theory of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis will be introduced. In part II, the final presentation of the project is typically at the MIT (Cambridge). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc. Results are presented at an international student competition at the MIT (Cambridge).

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

For students of the study programme Biology BSc the course can only be selected as 4th concept course.

This course offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.
Biology is becoming increasingly quantitative and mathematical modeling is now an integral part of biological research. In many biological processes, ranging from gene-expression to evolution, randomness plays an important role that can only be understood using stochastic models. This course will provide the students with a theoretical foundation for developing such stochastic models and analyzing them with an eye on biological applications. This course will teach students the tools and techniques for modeling and analyzing random phenomena. Throughout the course, several biological applications will be discussed and students will be encouraged to do additional reading based on their research interests.

The first half of the course will cover the basics of Probability Theory while the second half will delve into the theory of Stochastic Processes. The aim of this course is to introduce certain topics in Probability Theory and Stochastic Processes that have been specifically selected from the following books:

1. The mathematical representation of random phenomena: The probability space, properties of the probability measure, Independence of events, Conditional probability and Bayes formula, applications to parameter inference.


3. Convergence of Random Variables: Modes of convergence, Laws of large numbers, the central limit theorem, the law of the iterated logarithm, Applications to the analysis of cell population data.


While no specific textbook will be followed, much of the material and homework problems will be taken from the following books:

- **An Introduction to Probability Theory and Stochastic Processes with Applications to Biology**

The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.
Objective
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:
* models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics
* stochastic processes
Attendees will apply these concepts to a number of applications yielding biological insight into:
* epidemiology
* pathogen evolution
* macroevolution of species

Content
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes
Slides of the lecture will be available online.

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics.

Research Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>636-0801-00L</td>
<td>Research Project</td>
<td>O</td>
<td>20</td>
<td>46A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students get acquainted with scientific working methods and deepen their knowledge in a particular research area.

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>636-0900-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>40</td>
<td>91D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is carried out under the supervision of a professor in a research group of the D-BSSE, usually at the D-BSSE. Students are free to choose the area.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

Compulsory Electives in Humanities, Social and Political Sciences

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

Abstract
This seminar will feature invited lectures about recent advances and developments in systems biology, including topics from biology, bioengineering, and computational biology.

Objective
To provide an overview of current systems biology research.

Content
The final list of topics will be available at http://www.bsse.ethz.ch/education/.

Biotechnology Master - Key for Type

<table>
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<tr>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>O</td>
<td>Compulsory</td>
<td></td>
<td></td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>Key for Hours</td>
<td>Description</td>
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<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Certificate of Advanced Studies in Computer Science

Compulsory Major Courses

Neither credits can be obtained from entrance exams nor credited to the Certificate programme.

The lecture 151-0107-00L High Performance Computing for Science and Engineering I in the autumn semester can only together with the lecture 401-0886-10L High Performance Computing for Science and Engineering II in the spring semester be accredited as compulsory major course.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0206-00L</td>
<td>Visual Computing</td>
<td>W</td>
<td>8</td>
<td>4V+3U</td>
<td>M. Gross, M. Polieeyes</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course acquaints students with core knowledge in computer graphics, image processing, multimedia and computer vision. Topics include: Graphics pipeline, perception and camera models, transformation, shading, global illumination, texturing, sampling, filtering, image representations, image and video compression, edge detection and optical flow.</td>
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<tr>
<td>Objective</td>
<td>This course provides an in-depth introduction to the core concepts of computer graphics, image processing, multimedia and computer vision. The course forms a basis for the specialization track Visual Computing of the CS master program at ETH.</td>
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<tr>
<td>Content</td>
<td>Course topics will include: Graphics pipeline, perception and color models, camera models, transformations and projection, projections, lighting, shading, global illumination, texturing, sampling, filtering, image representations, convolution, linear filtering, diffusion, nonlinear filtering, edge detection, optical flow, image and video compression.</td>
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<tr>
<td>Lecture notes</td>
<td>Will be handed out.</td>
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<tr>
<td>252-0209-00L</td>
<td>Algorithms, Probability, and Computing</td>
<td>W</td>
<td>8</td>
<td>4V+2U+1A</td>
<td>E. Welzl, T. Holenstein, A. Steger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced design and analysis methods for algorithms and data structures: Random(ized) Search Trees, Point Location, Minimum Cut, Linear Programming, Randomized Algebraic Algorithms (matchings), Probabilistically Checkable Proofs (introduction).</td>
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<tr>
<td>Objective</td>
<td>Studying and understanding of fundamental advanced concepts in algorithms, data structures and complexity theory.</td>
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<tr>
<td>Content</td>
<td>This course acquaints students with core knowledge in computer graphics, image processing, multimedia and computer vision. Topics include: Graphics pipeline, perception and camera models, transformation, shading, global illumination, texturing, sampling, filtering, image representations, image and video compression, edge detection and optical flow.</td>
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<tr>
<td>Lecture notes</td>
<td>Will be handed out.</td>
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<tr>
<td>252-0210-00L</td>
<td>Compiler Design</td>
<td>W</td>
<td>8</td>
<td>4V+3U</td>
<td>T. Gross</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course uses compilers as example to expose modern software development techniques. Compiler organization. Lexical analysis. Top-down parsing via recursive descent, table-driven parsers, bottom-up parsing. Symboltables, semantic checking. Code generation for a simple RISC machine: conditionals, loops, procedure calls, simple register allocation techniques.</td>
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<tr>
<td>Objective</td>
<td>Learn principles of compiler design, gain practical experience designing and implementing a medium-scale software system.</td>
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<tr>
<td>Content</td>
<td>This course uses compilers as example to expose modern software development techniques. The course introduces the students to the fundamentals of compiler construction. Students will implement a simple yet complete compiler for an object-oriented programming language for a realistic target machine. Students will learn the use of appropriate tools (parser generators); the implementation language is Java. Throughout the course, students learn to apply their knowledge of theory (automata, grammars, stack machines, program transformation) and well-known programming techniques (module definitions, design patterns, frameworks, software reuse) in a software project. Specific topics: Compiler organization. Lexical analysis. Top-down parsing via recursive descent, table-driven parsers, bottom-up parsing. Symboltables, semantic checking. Code generation for a simple RISC machine: expression evaluation, straight line code, conditionals, loops, procedure calls, simple register allocation techniques. Storage allocation on the stack, parameter passing, runtime storage management, heaps. Special topics as time permits: introduction to global dataflow and its application to register allocation, instruction scheduling.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufmann Publishers, 1997</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 252-0213-00L | Distributed Systems                         | W          | 8    | 6G+1A | F. Mattern, R. Wattenhofer  |
| Abstract     | Distributed control algorithms (mutual exclusion, logical clocks), communication models (RPC, synchronous/asynchronous communication, broadcast, events, tupel spaces), middleware, service- and resource-oriented architectures (SOAP, REST), security, fault-tolerance (failure models, consensus), replication (primary copy, 2PC, 3PC, Paxos, quorum systems), shared memory (spin locks, concurrency). Become acquainted with pertinent technologies and architectures of distributed systems. |            |      |       |                            |
| Objective    | We present the characteristics and concepts of distributed systems, and discuss distributed control algorithms (flooding, mutual exclusion, logical clocks), communications models (remote procedure call, client-server models, synchronous and asynchronous communication), abstract communication principles (broadcast, events, tupel spaces), name services, communication middleware for open systems (e.g., REST, SOAP), infrastructure for ad hoc networking (JINI), cloud computing, and mechanisms for security and safety. Having a distributed system may permit getting away with failures and malfunctions of parts of the system. We discuss fault-tolerance issues (models, consensus, agreement) as well as replication issues (primary copy, 2PC, 3PC, Paxos, quorum systems, distributed storage) and problems with asynchronous multiprocessing (shared memory, spin locks, concurrency). To get familiar with message passing communication, some of the exercises will be devoted to a practical lab where participants will develop software for a mobile platform (smartphones). |            |      |       |                            |
| Content      | Become acquainted with pertinent technologies and architectures of distributed systems. |            |      |       |                            |
| Prerequisites / notice | Prior exposure to modern techniques for program construction, knowledge of at least one processor architecture at the assembly language level. |            |      |       |                            |


Content

Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

► Focus Courses and Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>252-0237-00L</td>
<td>Concepts of Object-Oriented Programming</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>P. Müller</td>
</tr>
</tbody>
</table>

Abstract
Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection

Objective
After this course, students will:
- Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features.
- Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs.
- Be able to learn new languages more rapidly.
- Be aware of many subtle problems of object-oriented programming and know how to avoid them.

Content
The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.

The topics discussed in the course include among others:
- The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing)
- The key problems of single and multiple inheritance and how different languages address them
- Generic type systems, in particular, Java generics, C# generics, and C++ templates
- The situations in which object-oriented programming does not provide encapsulation, and how to avoid them
- The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing
- How to maintain the consistency of data structures

Literature
Will be announced in the lecture.

Prerequisites / notice
Prerequisites:
Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming); programming experience

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<thead>
<tr>
<th>Number</th>
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<tr>
<td>252-0239-00L</td>
<td>Software Verification</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>B. Meyer, C. A. Furia, S. Nanz</td>
</tr>
</tbody>
</table>

Abstract
This course surveys some of the main approaches to software verification, including axiomatic semantics, abstract interpretation, model checking, and testing.

Objective
After successfully taking this course, students will have a theoretical and practical understanding of:
- The principles behind fundamental software verification techniques, including Hoare-style axiomatic semantics, abstract interpretation, model checking, and testing.
- Application of the principles to the construction of verification tools, in particular program provers.
- Research challenges in these areas.

Content
The idea of software verification has been around for decades, but only recently have the techniques become mature enough to be implemented and be applicable in practice. Progress has been made possible by the convergence of different techniques, originally developed in isolation.

This course embraces this diversity of approaches, by surveying some of the main ideas, techniques, and results in software verification. These include in particular:

* Axiomatic semantics, which provides a foundation of program correctness proofs by supplying a rigorous semantics of programs.
* Abstract interpretation, which provides a general framework to express and design static techniques for program analysis.
* Model checking, which provides efficient techniques for the exhaustive exploration of state-based models of programs and reactive systems.
* Testing, which provides the counterpart to exhaustive techniques by defining dynamic analyses to detect programming mistakes and correct them.

To demonstrate some of the techniques in practice, the course will offer a practical project requiring the application of verification tools to illustrative examples.
Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.

Abstract interpretation:

* Neil D. Jones, Flemming Nielson: Abstract Interpretation: a Semantic-Based Tool for Program Analysis

Model checking and real-time:


Testing:


252-0286-00L System Construction

**Abstract**
Main goal is teaching knowledge and skills needed for building custom operating systems and runtime environments. Relevant topics are studied at the example of sufficiently simple systems that have been built at our Institute in the past, ranging from purpose-oriented single processor real-time systems up to generic system kernels on multi-core hardware.

**Objective**
The lecture's main goal is teaching of knowledge and skills needed for building custom operating systems and runtime environments.

**Content**
- Case Study 1: Embedded System
  - Safety-critical and fault-tolerant monitoring system
  - Based on an auto-pilot system for helicopters
- Case Study 2: Multi-Processor Operating System
  - Universal operating system for symmetric multiprocessors
  - Shared memory approach
  - Based on Language/System Codesign (Active Oberon / A2)
- Case Study 3: Custom designed Single-Processor System
  - RISC Single-processor system designed from scratch
  - Hardware on FPGA
  - Graphical workstation OS and compiler (Project Oberon)
- Case Study 4: Custom-designed Multi-Processor System
  - Special purpose heterogeneous system on a chip
  - Massively parallel hard- and software architecture based on message passing
  - Focus: dataflow based applications

**Lecture notes**
Printed lecture notes will be delivered during the lecture. Slides will also be available from the lecture homepage.

252-0293-00L Wireless and Mobile Computing for Entertainment

**Applications**
Wireless and Mobile Computing for Entertainment with focus on dataflow based applications.

**Abstract**
This course gives a detailed overview about the 802 standards and summarizes the state of the art for WLANs, WPANs, and WMANs, including new topics such as mesh networks, cognitive radio, and visible light networks. The course combines lectures with a set of assignments in which students are asked to work with a simple JAVA simulation software.

**Objective**
The objective of the course is to learn about the general principles of wireless communications, including physics, frequency spectrum regulation, and standards. Further, the most up-to-date standards and protocols used for wireless LAN IEEE 802.11, Bluetooth and Wi-Fi, mesh networks, sensor networks, cellular networks, visible light communication, and cognitive radios, are analyzed and evaluated. Students develop their own add-on mobile computing algorithms to improve the behavior of the systems, using a JAVA-based event-driven simulator. We also hand out embedded systems that can be used for experiments for optical communication.

**Content**

**Lecture notes**
The script will be made available from the course webpage.

**Literature**
(1) The course blog at http://blogs.ethz.ch/stefanmangold/
(2) The course webpage at http://www lst.ifi.ethz.ch/teaching/lectures/hs14/293/index.html
(3) The JAVA simulation kernel "jernula"
(4) The JAVA 802 protocol emulator "JEムula802"

**Prerequisites / notice**
Students should have interest in wireless communication, and should be familiar with JAVA programming.

252-0341-01L Information Retrieval

**Abstract**
Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Advances in mobile devices and communication technologies have led to a rapid increase in demands for various forms of mobile information systems where the users, the applications and the databases themselves may be mobile. Based on both lectures and breakout sessions, this course examines the impact of the different forms of mobility and collaboration that systems require nowadays and how these influence the design of systems at the database, the application and the user interface level. For example, traditional data management techniques have to be adapted to meet the requirements of such systems and cope with new connection, access and synchronisation issues. As mobile devices have increasingly become integrated into the users’ lives and are expected to support a range of activities in different environments, applications should be context-aware, adapting functionality, information delivery and the user interfaces to the current environment and task. Various forms of software and hardware sensors may be used to determine the current context, raising interesting issues for discussion. Finally, user mobility, and the varying and intermittent connectivity that it implies, gives rise to new forms of dynamic collaboration that require lightweight, but flexible, mechanisms for information synchronisation and consistency maintenance. Here, the interplay of mobile, personal and social context will receive special attention.

The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. Topics to be covered include: databases of mobile objects; context-aware services; opportunistic information sharing; ambient information; pervasive display systems.

Topics covered include

- security requirements & risk analysis,
- system modeling and model-based development methods,
- implementation-level security, and
- evaluation criteria for the development of secure systems.

The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. Topics to be covered include: databases of mobile objects; context-aware services; opportunistic information sharing; ambient information; pervasive display systems.

Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. Topics to be covered include: databases of mobile objects; context-aware services; opportunistic information sharing; ambient information; pervasive display systems.
Content

Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software. Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems

Modules taught:

1. Introduction
   - Introduction of Infsec group and speakers
   - Security meets SW engineering: an introduction
   - The activities of SW engineering, and where security fits in
   - Overview of this class
2. Requirements Engineering: Security Requirements and some Analysis
   - overview: functional and non-functional requirements
   - use cases, misuse cases, sequence diagrams
   - safety and security
   - FMEA, FTA, attack trees
3. Modeling in the design activities
   - structure, behavior, and data flow
   - class diagrams, statecharts
4. Model-driven security for access control (design)
   - SecureUML as a language for access control
   - Combining Design Modeling Languages with SecureUML
   - Semantics, i.e., what does it all mean,
   - Generation
   - Examples and experience
5. Model-driven security (Part II)
   - Continuation of above topics
6. Security patterns (design and implementation)
7. Implementation-level security
   - Buffer overflows
   - Input checking
   - Injection attacks
8. Testing
   - overview
   - model-based testing
   - testing security properties
9. Risk analysis and management 1 (project management)
   - "risk": assets, threats, vulnerabilities, risk
   - risk assessment: quantitative and qualitative
   - safeguards
   - generic risk analysis procedure
   - The OCTAVE approach
10. Risk analysis: IT baseline protection
    - Overview
    - Example
11. Evaluation criteria
    - CMM
    - systems security engineering CMM
    - common criteria
12. Guest lecture
    - TBA

Literature

- Further relevant books and journal/conference articles will be announced in the lecture.

Prerequisites / notice

Prerequisite: Class on Information Security
Abstract

This course will focus on the algorithms for inference and learning with statistical models. We use a framework called probabilistic graphical models which include Bayesian Networks and Markov Random Fields.

We will use examples from traditional vision problems such as image registration and image segmentation, as well as recent problems such as object recognition.

Objective

Students will be introduced to probabilistic graphical models and will learn how to apply them to problems in image analysis and understanding. The focus will be to study various algorithms for inference and parameter learning.

Literature

Will be announced during the lecture.

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### 252-0535-00L Machine Learning

**W** 6 credits 3V+2U J. M. Buhmann

**Abstract**

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

**Objective**

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistical knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

**Content**

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighour
- Dimension reduction: principal component analysis (PCA) and beyond

**Prerequisites / notice**

Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

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### 252-0543-01L Computer Graphics

W 6 credits 3V+2U M. Gross

**Abstract**

This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.

**Objective**

This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and rendering, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

**Content**

The programming assignments will be in C++. This will not be taught in the class.

**Prerequisites / notice**

Solid fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended.

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### 252-0546-00L Physically-Based Simulation in Computer Graphics

W 4 credits 2V+1U B. Solenthaler, B. Thomaszewski

**Abstract**

This lecture provides an introduction to physically-based simulation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

**Objective**

The lecture covers topics in physically-based modeling such as particle systems, mass-spring models, finite difference and finite element methods. These approaches are used to represent and simulate deformable objects or fluids with applications in animated movies, 3D games and medical systems. Furthermore, the lecture covers topics such as rigid body dynamics, collision detection, and character animation.

**Prerequisites / notice**

Fundamentals of calculus and physics, basic concepts of algorithms and data structures, basic programming skills in C++. Knowledge on numerical mathematics as well as ordinary and partial differential equations is an asset, but not required.

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### 252-1407-00L Algorithmic Game Theory

W 7 credits 3V+2U+1A P. Widmayer

**Abstract**

Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.

**Objective**

Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks

Prerequisites / notice
Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

**252-1411-00L Security of Wireless Networks**

Abstract
Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques.

Objective
After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.

Content

**252-1414-00L System Security**

Abstract
The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems, such as host based intrusion detection systems. In the second part, the focus is on system design and methodologies for large projects.

Objective
In this lecture, students learn about the security requirements and capabilities that are expected from modern hardware, operating systems and other software environments. An overview of available technologies, algorithms and standards is given, with which these requirements can be met.

Content
The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for large projects. The main question answered is how to get a large secure system. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security (java...), logging and auditing (BSM audit, dtrace, ...), cryptographic support, TCG, secure file systems, dos/windows/ windowsXP security issues.

Along the lectures, model cases will be elaborated and evaluated in the exercises.

**252-1425-00L Geometry: Combinatorics and Algorithms**

Abstract
Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)

Objective
The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains. In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.

Content
Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in Rd, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.

**252-3610-00L Smart Energy**

Abstract
The lecture covers the role of ICT for sustainable energy usage. Concepts of the emerging smart grid are outlined and approaches to motivate sustainable consumer choices are explained. The lecture combines technologies from ubiquitous computing and traditional ICT with insights from socio-psychological concepts and illustrates them with examples from actual applications.
The goals of the course are, firstly, to give students a broader perspective on OS design than that provided by knowledge of Unix or Windows, building on the material in a standard undergraduate operating systems class, and secondly, to provide them with practical experience in dealing directly with the concurrency, resource management, and abstraction problems confronting OS designers and implementers.

Content
This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

Objective
The course is intended to give students a thorough understanding of design and implementation issues for modern operating systems. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

Prerequisites / notice
The course consists of lectures, project work, and a written examination. Project work will be performed in small groups, where students will implement major components of a microkernel-based operating system. The final assessment will be a combination of project and examination grades.

263-4640-00L
Advanced Operating Systems
This course discusses fundamental concepts and technologies in the area of network security. Several case studies illustrate the dark side of the Internet and explain how to protect against such threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

6 credits
A. Perrig, T. P. Dübendorfer, S. Frei

263-2800-00L
Design of Parallel and High-Performance Computing
Advanced topics in parallel / concurrent programming.

W 7 credits
3V+2U+1A
T. Hoefler, M. Püschel

Objective
Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

Content
The goal of this course is to give an overview of Big Data technologies. All aspects are covered: data formats and models, programming languages, optimization techniques, systems, and applications.

Literature
Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

263-3010-00L
Big Data
One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value. To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the data fast, and applying complex operations to the data.

W 6 credits
3V+1U+1A
T. Hofmann

Abstract
One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value. To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the data fast, and applying complex operations to the data.

Objective
One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value. To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the data fast, and applying complex operations to the data.

Content
The goal of this course is to give an overview of Big Data technologies. All aspects are covered: data formats and models, programming languages, optimization techniques, systems, and applications.

Literature
Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

263-4510-00L
Network Security
This course discusses fundamental concepts and technologies in the area of network security. Several case studies illustrate the dark side of the Internet and explain how to protect against such threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

W 6 credits
2V+1U+2P
A. Perrig, T. P. Dübendorfer, S. Frei

Abstract
This course discusses fundamental concepts and technologies in the area of network security. Several case studies illustrate the dark side of the Internet and explain how to protect against such threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

263-5703-00L
Multimedia Communications
Understanding principles of multimedia communications and getting an illustrative overview of available and emerging technology.

W 4 credits
2V+1U+1A
A. Smolic

Abstract
After a summary of fundamentals in signal processing and information theory, an introduction to processing and coding of different types of multimedia is given.

Objective
After a summary of fundamentals in signal processing and information theory, an introduction to processing and coding of different types of multimedia is given. This starts with speech (PCM, vocoder, CELP etc.), continues over audio (MP3, AAC etc.), still images (JPEG etc.), video (MPEG-2, MPEG-4, H.264/AVC, HEVC etc.), and interactive graphics (MPEG-4), to emerging and future multimedia content such as 3D video, free viewpoint video, high dynamic range video. Algorithms as well as human perception will be addressed.

Content:
- Fundamentals of information theory
- Fundamentals of signal processing and coding
- Speech processing and coding
- Audio processing and coding
- Still image processing and coding
- Video processing and coding
- Emerging multimedia (3D video, free viewpoint video, HDR, HFR)

263-4050-00L
Complexity Theory
Complexity Theory classifies problems according to the difficulty of solving them. In this course, we give an introduction to complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, NP, AM, PH, PSPACE, IP, EXP), and study circuit complexity.

W 6 credits
3V+2U T. Holenstein

Abstract
Complexity Theory classifies problems according to the required resources in order to solve them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, PSPACE, IP, EXP), and study circuit complexity.

Objective
The student learns the fundamentals of Complexity Theory, as well as some of the more recent techniques. He not only understands the basic results and techniques used to prove them, but also has insight in some of the technically more advanced theorems.

Content
Complexity Theory classifies problems according to the difficulty of solving them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, PSPACE, IP, EXP), and study the known relationship to uniform complexity. We study circuit complexity, and its relationship to uniform complexity. We also will study some circuit lower bounds for constant depth circuits, as well as results which explain why it is difficult to improve these results.

263-3800-00L
Advanced Operating Systems
This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

W 6 credits
2V+2U+1A
T. Roscoe

Abstract
The goals of the course are, firstly, to give students a broader perspective on OS design than that provided by knowledge of a smart grid infrastructure and its applications, know the role of ubiquitous computing technologies, can explain the challenges regarding security and privacy, can reflect the basics cues to induce changes in consumer behavior, develop a general understanding of the effects of a smart grid infrastructure on energy efficiency, and know how to apply the learning to related design projects.

Content
- Background on energy generation and consumption; characteristics, potential, and limitations of renewable energy sources
- Introduction to energy economics
- Smart grid and smart metering infrastructures, virtual power plants, security challenges
- Demand management and home automation using ubiquitous computing technologies
- Changing consumer behavior with smart ICT
- Benefits challenges of a smart energy system

Literature
Will be provided during the course, though a good starting point is "ICT for green: how computers can help us to conserve energy" from Friedemann Mattern, Thosten Staake, and Markus Weiss (available at http://www.vs.inf.ethz.ch/publ/papers/ICT-for-Green.pdf).

Prerequisites / notice
The lecture includes interactive exercises, case studies and practical examples.
Objective

Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures. Students can identify and assess known vulnerabilities in a software system that is connected to the Internet. Students have an in-depth understanding of important security technologies. Students know how to configure a real firewall and know some penetration testing tools from their own experience.

Content

Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture. This lecture and the exam are held in English.

Prerequisites / notice

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

263-5001-00L

Introduction to Finite Elements and Sparse Linear System Solving

W 4 credits 2V+1U P. Arbenz, T. Kaman

Abstract

The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that are typical for the FE method. We will consider direct and iterative methods.

Objective

Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.

Content

I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.
(2) 1D problems. Piecewise polynomials in 1D.
(3) 2D problems. Triangulations. Piecewise polynomials in 2D.
(4) Variational formulations. Galerkin finite element method.
(5) Implementation aspects.

II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.
(7) Sparse matrices.
(8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.
(10) Preconditioned conjugate gradient method (PCG).
(11) Incomplete factorization preconditioning.
(12) Multigrid preconditioning.
(13) Non-symmetric problems (GMRES, BiCGstab).
(14) Indefinite problems (SYMMLQ, MINRES).

Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science. The exercises are made with Matlab.

263-5150-00L

Scientific Databases

W 4 credits 2V+1U G. H. Gonnet

Abstract

Scientific databases share many aspects with classical DBs, but have additional specific aspects. We will review Relational DBs, Object Oriented DBs, Knowledge DBs, textual DBs and the Semantic Web. All these topics will be studied from the point of view of the scientific applications (Bioinformatics, Physics, Chemistry, Health, Engineering). A toy SDB will be used for exercises.

Objective

The goals of this course are to:
(a) Familiarize the students with how existing DBs can be used for scientific applications.
(b) Recognize the areas where SciDBs differ and require additional features compared to classical DBs.
(c) Be able to understand more easily SciDBs, improve existing ones or design/create new ones.
(d) Familiarize the students with at least two examples of SciDBs.
Content

1) - Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area. Efficiency issues and how they differ from classical DB.

2) - Relational DB used for scientific data, pros/cons. Introduction to RDB, limitations of the model, basics of SQL, handling of metadata, examples of scientific use of RDBs.

3) - Object Oriented DB. Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching, Space and access time efficiency of OODBs.

4) - Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.

5) - MapReduce / Hadoop

6) - Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.

7) - SGML and XML, human-readable databases, genomic databases. Advantages of human-readable databases (the huge initial success of genomic databases).

8) - Semantic web, Resource Description Framework (RDF) triples, SparQL. An example of very flexible database for knowledge storage. Goals of the Semantic Web, discussion about its future.

9) - An ideal scenario (and the design of a toy system with most of the desired features for exploration and exercises).


11) - Functional testing, Verifiers, Consistency, Short-circuit testing, Recovery and Automatic recovery, Backup (incremental) methods.

12) - Performance and space issues, various uses of compression, concurrency control. Hardware issues, clusters, Cloud computing, Crowd-sourcing.

13) - Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

Literature

Several papers and online articles will be made available. There is no single textbook for this course. A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

263-5200-00L Data Mining: Learning from Large Data Sets

W 4 credits 2V+1U

A. Krause

Abstract
Many scientific and commercial applications require insights from massive, high-dimensional data sets. This courses introduces principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course both covers theoretical foundations and practical applications.

Objective
In this graduate-level course, we will study principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will both cover theoretical foundations and practical applications.

Content
Topics covered:
- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems

Prerequisites / notice
Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

263-5210-00L Probabilistic Artificial Intelligence

W 4 credits 2V+1U

A. Krause

Abstract
This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

Objective
How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.

Content
Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximative inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites / notice
Solid basic knowledge in statistics, algorithms and programming
The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Biological Systems. Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational techniques and models. The aim is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks. The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear problems and basic combinatorial optimization problems. The course will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

### Objective
- Introduce basic techniques and problems of mathematical optimization.
- Topics covered in this course include:
  - Linear programming (simplex method, duality theory, shadow prices, ...).
  - Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

### Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

### Prerequisites / notice
- Fundamentals of Probability, Fundamentals of Computational Modeling

### Content
- Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

### Lecture notes
- Material for exercises, copies of transparencies.

### Introduction to Mathematical Optimization
- 5 credits
- 2V+1U
- R. Zenklusen

### Computer Vision
- The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicores architectures.

### Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

### Prerequisites / notice
- Fundamentals of Probability, Fundamentals of Computational Modeling

### Content
- Topics covered in this course include: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

### Lecture notes
- Material for exercises, copies of transparencies.

### Introduction to Mathematical Optimization
- 5 credits
- 2V+1U
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### Computer Vision
- The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicores architectures.

### Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

### Prerequisites / notice
- Fundamentals of Probability, Fundamentals of Computational Modeling

### Content
- Topics covered in this course include: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

### Lecture notes
- Material for exercises, copies of transparencies.
### Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-3001-00L</td>
<td>Advanced Topics in Information Systems Number of participants limited to 16.</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Norrie</td>
</tr>
<tr>
<td>Abstract</td>
<td>This seminar course will discuss research topics in the area of information systems. We will read recent research papers on a selected topic, and present/discuss them in class.</td>
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<tr>
<td>Objective</td>
<td>The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.</td>
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<tr>
<td>Content</td>
<td>Each participant will be required to give a presentation of about 30 mins followed by a discussion on an assigned topic. In addition, each participant will be assigned as a buddy on another paper which means that they must read the paper and be prepared to start of the discussion on the paper with some comments and questions. Students also have to submit a 2-page summary of the paper that they present. Grading will depend on the quality of the talk, the report, and also active participation during the seminar.</td>
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<tr>
<td>252-4202-00L</td>
<td>Seminar in Theoretical Computer Science</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>E. Welzl, B. Gärtnert, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov</td>
</tr>
<tr>
<td>Abstract</td>
<td>Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.</td>
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<tr>
<td>Objective</td>
<td>The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.</td>
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<tr>
<td>Content</td>
<td>The topics will be presented in the first session of the seminar.</td>
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<tr>
<td>Literature</td>
<td>The reading list will be published on the course web site.</td>
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<tr>
<td>252-4601-00L</td>
<td>Current Topics in Information Security</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>D. Basin, S. Capkun, A. Perrig</td>
</tr>
<tr>
<td>Abstract</td>
<td>The seminar covers various topics in information security: security protocols (models, specification &amp; verification), trust management, access control, non-interference, side-channel attacks, identity-based cryptography, host-based attack detection, anomaly detection in backbone networks, key-management for sensor networks.</td>
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<tr>
<td>Objective</td>
<td>The main goals of the seminar are the independent study of scientific literature and assessment of its contributions as well as learning and practicing presentation techniques.</td>
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<tr>
<td>Content</td>
<td>The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.</td>
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<tr>
<td>Literature</td>
<td>The reading list will be published on the course web site.</td>
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<tr>
<td>252-5051-00L</td>
<td>Advanced Topics in Machine Learning</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Buhmann, T. Hofmann, A. Krause</td>
</tr>
<tr>
<td>Abstract</td>
<td>In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning.</td>
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<tr>
<td>Objective</td>
<td>The seminar &quot;Advanced Topics in Machine Learning&quot; familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.</td>
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<tr>
<td>Content</td>
<td>The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.</td>
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<tr>
<td>Literature</td>
<td>The reading list will be published on the course web site.</td>
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<tr>
<td>252-5701-00L</td>
<td>Advanced Topics in Computer Graphics and Vision</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Gross, M. Pollefeys, O. Sorkine Hornung</td>
</tr>
<tr>
<td>Abstract</td>
<td>This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.</td>
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<td>Objective</td>
<td>The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills.</td>
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<tr>
<td>Content</td>
<td>This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers are selected covering topics such as modeling, rendering, animation, real-time graphs, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics.</td>
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<tr>
<td>Literature</td>
<td>Individual research papers are selected each term. See <a href="http://graphics.ethz.ch/">http://graphics.ethz.ch/</a> for the current list.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The courses &quot;Computer Graphics I and II&quot; (GDV I &amp; II) are recommended, but not mandatory.</td>
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<tr>
<td>263-2100-00L</td>
<td>Research Topics in Software Engineering</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>P. Müller</td>
</tr>
<tr>
<td>Abstract</td>
<td>This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.</td>
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<tr>
<td>Objective</td>
<td>Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).</td>
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</tbody>
</table>
The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering. To accomplish that, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools.

The publications to be presented will be announced on the seminar home page at least one week before the first session.

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar's home page for information.

<table>
<thead>
<tr>
<th>263-4200-00L</th>
<th>Seminar SAT</th>
<th>W</th>
<th>2 credits</th>
<th>E. Welzl</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective</strong></td>
<td>Study and presentation of research papers from the literature on &quot;Boolean Satisfiability-Combinatorics and Algorithms&quot;.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Goal of this seminar is to study and present, in continuation of the course &quot;Boolean Satisfiability-Combinatorics and Algorithms&quot;, research papers from the literature.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>A list of papers for presentations will be distributed at the beginning of the seminar.</td>
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</table>

<table>
<thead>
<tr>
<th>263-4203-00L</th>
<th>Geometry: Combinatorics and Algorithms</th>
<th>W</th>
<th>2 credits</th>
<th>B. Gärtner, E. Welzl</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective</strong></td>
<td>Each student is expected to read, understand, and elaborate on a selected research paper. To this end, (s)he should give a 45-min. presentation about the paper. The process includes</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>* getting an overview of the related literature;</td>
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<td>* understanding and working out the background/motivation;</td>
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<td></td>
<td>* why and where are the questions addressed relevant?</td>
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<td>* understanding the contents of the paper in all details;</td>
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<tr>
<td></td>
<td>* selecting parts suitable for the presentation;</td>
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<tr>
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<td>* presenting the selected parts in such a way that an audience</td>
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<td>with some basic background in geometry and graph theory can easily understand and appreciate it.</td>
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<td></td>
<td>To attend the seminar, some basic knowledge in (discrete and computational) geometry and graphs and algorithms is required. Thus, previous participation in some of the courses &quot;Graphs and Algorithms&quot;, &quot;Computational Geometry&quot;, &quot;Geometric Graphs: Combinatorics &amp; Algorithms&quot;, or similar courses is strongly encouraged. It is also possible to take this seminar in parallel to the lecture &quot;Computational Geometry&quot;.</td>
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</table>

Certificate of Advanced Studies in Computer Science - Key for Type

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

Key for Hours

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

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### CAS in Nutrition for Disease Prevention and Health

#### Disciplinary Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6101-00L</td>
<td>Nutrition and Chronic Disease (HS)</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
</tr>
</tbody>
</table>

**Abstract**
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes**
There is no script. Powerpoint presentations will be made available on-line to students.

**Prerequisites / notice**
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-6403-00L</td>
<td>Nutrition and Performance</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>S. Mettler, M. B. Zimmermann</td>
</tr>
</tbody>
</table>

**Abstract**
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

**Objective**
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

**Content**
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise.

Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

**Lecture notes**
Lecture slides and required handouts will be available on the ETH website.

**Literature**
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

**Prerequisites / notice**
The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Eichholzer</td>
</tr>
</tbody>
</table>

**Abstract**
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

**Objective**

- Students are able
  - to evaluate the scientific evidence on the effects of diet on human health
  - to describe the role of nutritional factors in the prevention of chronic diseases
  - to assess the nutritional status of a population (Switzerland taken as an example)
  - to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

**Content**
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

### CAS in Nutrition for Disease Prevention and Health - Key for Type

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

<table>
<thead>
<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.

Chemistry (General Courses)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0073-00L</td>
<td>Radiochemistry</td>
<td>E-</td>
<td>2</td>
<td>2V</td>
<td>M. Badertscher</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles and phenomena around radioactivity. Knowledge of the most important phenomena in relation with radioactivity. Knowledge of the principles of radiation protection. Ability to judge dangerous situations in handling radioactive materials, geopolitically as well as locally at ones own working place.</td>
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<tr>
<td>Objective</td>
<td>Structure and properties of atomic nuclei, mathematical description of the radioactive decay, decay types, interaction of radiation with matter, detectors for ionizing radiation, radiation protection, principles of isotope separation, nuclear power plants, major nuclear accidents. Additional topics may be suggested by the students.</td>
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<tr>
<td>Lecture notes</td>
<td>A script is available free of charge.</td>
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Weitere Literaturangaben werden nach Bedarf in der Vorlesung abgegeben.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0075-00L</td>
<td>Radiochemistry (Practical Training)</td>
<td>E-</td>
<td>4</td>
<td>4P</td>
<td>M. Badertscher</td>
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<tr>
<td>Objective</td>
<td>Knowledge of the most important phenomena in relation with radioactivity. Knowledge of the principles of radiation protection. Ability to handle radioactive material.</td>
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<tr>
<td>Content</td>
<td>Handling open and closed radioactive sources. Getting accustomed to a variety of instruments and detectors for various kinds of ionizing radiation. Acquisition of working techniques under consideration of radiation protection.</td>
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<tr>
<td>Lecture notes</td>
<td>Comprehensive material is available online.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This Praktikum is also an integral part of the Praktikum 529-0057-01L &quot;Analytische Chemie&quot;.</td>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>Institute-Seminar covering current research Topics in Physical Chemistry</td>
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<thead>
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<th>Lecturers</th>
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<tr>
<td>529-1100-00L</td>
<td>Fragrance Chemistry</td>
<td>E-</td>
<td>1</td>
<td>V</td>
<td>T. Mäder</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture provides a journey into the molecular world of scents from the chemical secrets behind Chanel N°5 to structure-odor relationships, industrial processes, and total synthesis of terpenoids. Each subunit is centered on one odorant family and highlights a certain class of chemical reactions, illustrated by prominent perfumery examples.</td>
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<tr>
<td>Objective</td>
<td>After completion of this lecture module the students know all the major perfumery materials of the important odor families with their academic and industrial syntheses, their olfactory properties, their usage, their historic perspective, and today's economic importance. The students can approximate the conformational space of odorants and especially macrocycles on the basis of simple rules, and know how olfactophore models are used. The latter enables them to further their education in perfumery at specialized Universities such as the ISIPCA in Versailles; yet, the student also knows about the links of Fragrance Chemistry with Pharmaceutical Chemistry and the Specialty Chemicals business in general.</td>
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<td>529-0688-00L</td>
<td>Safety Lecture for Assistants</td>
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<tr>
<td>Abstract</td>
<td>Safety-Praxis und Riskmanagement in Laboratorien</td>
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<tr>
<td>Objective</td>
<td>Gute Safety-Praxis</td>
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</tr>
<tr>
<td>Content</td>
<td>Safety-Regeln, Riskmanagement im Labor, Safety-Parcours</td>
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Chemistry (General Courses) - Key for Type

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

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<tr>
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<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>independent project</td>
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<tr>
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<td>colloquium</td>
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ECTS European Credit Transfer and Accumulation System

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## Chemistry Bachelor

### 1. Semester

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<th>Lecturers</th>
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<tr>
<td>529-0011-02L</td>
<td>General Chemistry (Inorganic Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>A. Togni</td>
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<tr>
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<td>Abstract</td>
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<tr>
<td></td>
<td>Introduction to the chemistry of ionic equilibria: Acids and bases, redox reactions, formation of coordination complexes and precipitation reactions</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>Understanding and describing ionic equilibria from both a qualitative and a quantitative perspective</td>
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<td>Content</td>
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<td></td>
<td>Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium concentrations, acidity functions, Lewis acids, acids in non-aqueous solvents, redox reactions and equilibria, Galvanic cells, electrode potentials, Nernst equation, coordination chemistry, stepwise formation of metal complexes, solubility</td>
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<td></td>
<td>Lecture notes</td>
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<td>Copies of the course slides as well as other documents will be provided as pdf files via the ILIAS platform (myStudies)</td>
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<tr>
<td>529-0011-03L</td>
<td>General Chemistry (Organic Chemistry) I</td>
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<td>H. Wennemers</td>
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<td></td>
<td>Introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions.</td>
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<td></td>
<td>Introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry.</td>
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<td>Content</td>
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<td>Lecture notes</td>
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<td>Unterlagen werden als PDF über die ILIAS-Plattform zur Verfügung gestellt</td>
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<td>529-0011-01L</td>
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<td>F. Merkt</td>
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<td></td>
<td>Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.</td>
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<td></td>
<td>Introduction to Physical Chemistry</td>
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<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger's equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases</td>
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<td>Lecture notes</td>
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<td>See homepage of the lecture.</td>
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<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung.</td>
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<tr>
<td>551-0015-00L</td>
<td>Biology I</td>
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<td>2 credits</td>
<td>2V</td>
<td>R. Glockshuber, E. Hafen</td>
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<td>The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.</td>
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<td>The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.</td>
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<tr>
<td></td>
<td>Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch &quot;Biology&quot; (Campbell &amp; Rees, 7th edition, 2005) Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt</td>
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<td>1. Aufbau der Zelle</td>
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<td>Kapitel 5: Struktur und Funktion biologischer Makromoleküle</td>
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<td>Kapitel 6: Eine Tour durch die Zelle</td>
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<td>Kapitel 7: Membranstruktur und-funktion</td>
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<td>Kapitel 8: Einführung in den Stoffwechsel</td>
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<td>Kapitel 9: Zelluläre Atemung und Speicherung chemischer Energie</td>
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<td></td>
<td>Kapitel 10: Photosynthese</td>
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<td>Kapitel 12: Der Zellzyklus</td>
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<td>Kapitel 17: Vom Gen zum Protein</td>
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<td>Kapitel 13: Meiose und Reproduktionszyklen</td>
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<td>Kapitel 14: Mendel'sche Genetik</td>
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<td>Kapitel 15: Die chromosomale Basis der Vererbung</td>
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<td>Kapitel 16: Die molekulare Grundlage der Vererbung</td>
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<td>Kapitel 18: Genetik von Bakterien und Viren</td>
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<td>Kapitel 46: Tierische Reproduktion</td>
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<td>Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik</td>
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<tr>
<td></td>
<td>Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.</td>
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<td>Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:</td>
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<td>401-0271-00L</td>
<td>Mathematical Foundations I: Analysis A</td>
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<td>Introduction to calculus in one dimension. Building simple models and analysing them mathematically. Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.</td>
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<td>Objective</td>
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</table>

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Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.

D. W. Jordan, P. Smith: Mathematische Methoden für die Praxis, Spektrum Akademischer Verlag
R. Sperb/M. Akveld: Analysis I (vdf)
L. Papula: Mathematik für Ingenieure und Naturwissenschaftler (3 Bände), Vieweg

529-0001-00L
Introduction to Computer Science
O 4 credits 2V+2U P. H. Hünenberger

Introduction to UNIX, data representation, introduction to C++ programming, errors, algorithms, computer architecture, sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, software engineering.

For more information: www.csms.ethz.ch/education/infoL

Objective
Discuss fundamentals of computer architecture, languages, algorithms and programming with an eye to their application in the area of chemistry, biology and material science.

Content
Minimal introduction to UNIX, Data representation and processing, algorithms and programming in C++, Errors, programming guidelines, efficiency, computer architecture, algorithms for sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, style, software engineering.

Available (in English), distributed at first lecture

Lecture notes

Literature
See: www.csms.ethz.ch/education/infoL

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the written exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/infoL

Laboratory Courses

Number Title Type ECTS Hours Lecturers
529-0011-04L Practical Course General Chemistry n O 8 credits 12P H. V. Schönberg, E. C. Meister

Latest online enrolment is one week before the beginning of the semester.

Information about the practical course will be given on the first day.

Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration) analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements), metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration) analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes

http://www.gruetzmacher.ethz.ch/education/labcourses

Compulsory: online enrolment latest one week prior to the semester

3. Semester

Compulsory Subjects Examination Block I

Number Title Type ECTS Hours Lecturers
529-0121-00L Inorganic Chemistry I O 3 credits 2V+1U A. Mezzetti

Complexes of the transition metals: structure, bonding, spectroscopic properties, and synthesis.

Objective
Introduction to the binding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties. General synthetic strategies.

Content

Lecture notes

Can be bought at the HCI-shop

Literature

529-0221-00L Organic Chemistry I O 3 credits 2V+1U F. Diederich, C. Schaack

Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Objective
Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

Content
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Lecture notes

A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.

Literature
No set textbooks. Optional literature will be proposed at the beginning of the class and in the lecture notes.

529-0422-00L Physical Chemistry II: Introduction to Chemical Reaction Kinetics O 4 credits 3V+1U H. J. Wörner

Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

For more information: www.csms.ethz.ch/education/infoL
Abstract


Objective

Introduction to Chemical Reaction Kinetics

Content


Lecture notes


Literature


Prerequisites / notice

Voraussetzungen:
- Mathematik I und II
- Allgemeine Chemie I und II
- Physikalische Chemie I

402-0043-00L

Physics I

Abstract

Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Objective

The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

Content

Mechanics (motion, Newton’s laws, work and energy, conservation of momentum, rotation, gravitation, fluids)
Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).

Lecture notes

The lecture follows the book “Physics” by Paul A. Tipler.

Literature


Prerequisites / notice

Prerequisites: Mathematics I & II

529-0051-00L

Analytical Chemistry I

Abstract

Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Objective

Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) und optical rotation dispersion (ORD).

Lecture notes

Script will be for the production price

Literature

- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice

Excercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

401-0373-00L

Mathematics III: Partial Differential Equations

Abstract


Objective

The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.
Content

- Examples of partial differential equations
  - Classification of PDEs
  - Superposition principle

- One-dimensional wave equation
  - D'Alembert's formula
  - Duhamel's principle

- Fourier series
  - Representation of piecewise continuous functions via Fourier series
  - Examples and applications

- Separation of variables
  - Resolution of wave and heat equation
  - Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

- Laplace equation
  - Resolution of the Laplace equation on rectangle, disk and annulus
  - Poisson formula
  - Mean value theorem and maximum principle

- Fourier transform
  - Derivation and Definition
  - Inverse Fourier transformation and inversion formula
  - Interpretation and properties of the Fourier transform
  - Resolution of the heat equation

- Laplace transform
  - Definition, motivation and properties
  - Inverse Laplace transform of rational functions
  - Application to ordinary differential equations

Lecture notes

There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

Literature


2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press

3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)


It is required a minimal background of: 1) multivariables functions (Riemann integrals in two or three variables, change of variables in the integrals through the Jacobian, partial derivatives, differentiability, Jacobian) 2) numerical and functional sequences and series, basic knowledge of ordinary differential equations.

Laboratory Courses

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
529-0129-00L | Inorganic and Organic Chemistry II | O | 11 credits | 16P | A. Mezzetti, A. Togni

Abstract
Introduction to the experimental methods of Inorganic Chemistry

Objective
The teaching laboratory offers an insight into different aspects of Inorganic Chemistry, including solid state chemistry, organometallic chemistry, kinetics, etc.. The synthesis, characterization and analysis of inorganic compound are a main topic. Emphasis is given to scientific writing (experiment reports).

Content
Inorganic chemistry part: Synthesis and analysis of elemento-organic compounds, metal complexes, and organometallic compounds. Introduction to Schlenk techniques, solid state synthesis, and kinetics. Introduction in the chemistry library: literature data banks and collections of spectra.

Organic synthesis with organometallic compounds and catalysts: Experiments in the framework of a selected specialised project. Possible projects: Rh catalysed asymmetric hydrogenation of enamides, Mn-catalysed epoxidation of olefins, Cu catalysed Diels-Alder reactions, synthesis of organo-boron compounds and Pd catalysed coupling with halides, Ru catalysed transfer hydrogenation.

Lecture notes
A manual is distributed in the teaching laboratory.

Prerequisites / notice
Prerequisites:
- Practical Course General Chemistry (1. Semester, 529-0011-04)
- Practical Course Inorg. and Org. Chemistry I (2. Sem., 529-0230)

529-0132-00L | Inorganic Chemistry III: Organometallic Chemistry and Homogeneous Catalysis | O | 4 credits | 3G | A. Togni, A. Mezzetti

Abstract
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carboxylation, C-C bond-forming and related reactions.

Objective
Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to homogeneous catalysis.

Content
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carboxylation, C-C bond-forming and related reactions.

529-0231-00L | Organic Chemistry III: Introduction to Asymmetric Synthesis | O | 4 credits | 3G | E. M. Carreira

Abstract
Methods of Asymmetric Synthesis

Objective
Understanding of the basic principles of diastereoselective synthesis

5. Semester

Compulsory Subjects Examination Block II
Physical Chemistry IV: Magnetic Resonance

Objective

Introduction to magnetic resonance in isotropic and anisotropic phase.

Content

The course gives an introduction to magnetic resonance spectroscopy (NMR and EPR) in liquid, liquid crystalline and solid phase. It starts from a classical description in the framework of the Bloch equations. The implications of chemical exchange are studied and two-dimensional exchange spectroscopy is introduced. An introduction to Fourier spectroscopy in one and two dimensions is given and simple ‘pulse trickery’ is described. A quantum-mechanical description of magnetic resonance experiments is introduced and the spin Hamiltonian is derived. The chemical shift term as well as the scalar, dipolar and quadrupolar terms are discussed. The product-operator formalism is introduced and various experiments are described, e.g. polarization transfer. Applications in chemistry, biology, physics and medicine, e.g. determination of 3D molecular structure of dissolved molecules, determination of the structure of paramagnetic compounds and imaging (MRI) are presented.

Lecture notes

handed out in the lecture (in english)

Literature

see http://www.ssnmr.ethz.ch/education/PC_IV_Lecture

529-0432-00L

Physical Chemistry IV: Magnetic Resonance

ECTS 3G

Type Laboratory experiments to acquire a profound knowledge of spectroscopical methods and techniques in chemistry. Evaluation and detailed documentations to each experiment will be handed out.

Laboratory experiments: UV/VIS spectroscopy, luminescence spectroscopy, FT infrared spectroscopy, dye laser, light diffraction and visualization of measurement data. Writing lab reports.

Lecturers E. Meister, M. Ernst, G. Jeschke, R. Riek

529-0449-00L

Spectroscopy

ECTS 13 credits

Type Laboratory experiments to acquire a profound knowledge of spectroscopical methods and techniques in chemistry. Evaluation and visualization of measurement data. Writing lab reports.

Abstract Laboratory experiments: UV/VIS spectroscopy, luminescence spectroscopy, FT infrared spectroscopy, dye laser, light diffraction and refraction, laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), FT nuclear magnetic resonance spectroscopy (NMR), electron paramagnetic resonance spectroscopy (EPR), atomic force microscopy (AFM), Fourier transform methods.

Objective Laboratory experiments to acquire a profound knowledge of spectroscopical methods and techniques in chemistry. Evaluation and visualization of measurement data. Writing lab reports.

Content Laboratory experiments: UV/VIS spectroscopy, luminescence spectroscopy, FT infrared spectroscopy, dye laser, light diffraction and refraction, laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), FT nuclear magnetic resonance spectroscopy (NMR), electron paramagnetic resonance spectroscopy (EPR), atomic force microscopy (AFM), Fourier transform methods.

Lecture notes Detailed documentations to each experiment will be handed out.

Number 529-0141-00L

Physical Methods for Inorganic Chemistry

ECTS 6 credits

Type Introduction into the important methods for structural analysis (solid state NMR), crystal structure analysis and surface analysis techniques and their applications

Abstract Knowledge in solid state NMR, crystal structure analysis and surface analytical techniques relevant for inorganic materials

Objective This lecture course consists of three parts 1) Solid state NMR 2) Surface and direct solid analysis 3) Crystal structure analysis. Most important fundamentals of the individual methods will be presented and details will be explained on most relevant inorganic applications

Content Praktikum Physikalische und Analytische Chemie (529-0054-00) or Praktikum Physikalische Chemie (529-0054-01)

Lecture notes Will be given during the lectures

Number 529-0041-00L

Signal Processing

ECTS 6 credits

Type Introduction of the basics of signal processing in spectroscopy. Fourier transformation, linear response theory, stochastic signals, digital data processing, Fourier spectroscopy.

Abstract Basics of signal processing in spectroscopy


Content Script available

Lecture notes

Number 529-0041-00L

Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics

ECTS 6 credits

Type Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

Abstract Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

Objective Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation.

Content Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods.

Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods).

Employment of computer science for processing data in chemical analysis (chemometrics).

Lecture notes Lecture notes will be available in the lecture at production cost.

Literature Information about relevant literature will be available in the lecture & in the lecture notes.

Number 529-0141-00L

Physical Methods for Inorganic Chemistry

ECTS 6 credits

Type Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

Abstract Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

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### Biological Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

**Abstract**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymers and transcriptions factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Objective**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymers and transcriptions factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Content**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymers and transcriptions factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Lecture notes**
Mainly based on recent original literature, a detailed list will be distributed during the first lecture

### Chemical Aspects of Energy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>529-0659-00L</td>
<td>Electrochemistry</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>P. Novák</td>
</tr>
</tbody>
</table>

**Abstract**

**Objective**
Towards the end of the course the students will understand the basics of electrochemistry and will be able to describe and calculate electrochemistry-related matters in industrial processes and products.

**Content**

### Chemical Crystallography

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<tr>
<td>529-0039-00L</td>
<td>Principles of Crystal Structure Determination</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>M. D. Wörl, N. Trapp</td>
</tr>
</tbody>
</table>

**Abstract**
An introduction to the principles of X-ray diffraction and crystal structure determination as it relates to Chemistry.

**Objective**
To gain an understanding of the principles of crystal structure determination by X-ray diffraction.

**Content**
Basic crystallographic concepts: Unit cells, Bravais lattices, Laue symmetry, crystal classes (point groups), space groups, crystal growth, instrumentation, diffraction of X-rays by crystals: physical and geometric basics, powder and single crystal methods, structure solution and modelling, interpretation of crystal structure data; internal coordinates for structure description: atom spacing, co-ordination polyhedra, bond angles, torsion angles; intermolecular interactions, absolute configuration determination. Overview of inorganic, organic and macromolecular databases.

**Lecture notes**
The script and exercises will be distributed weekly in loose form

**Literature**
Main reference


### Computational Chemistry

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<th>Number</th>
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<tbody>
<tr>
<td>529-0002-00L</td>
<td>Algorithms and Programming in C++</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>S. Rinker</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to algorithms (special focus on chemistry); Design of algorithms, data structures, search and sort algorithms, graphs, numerical algorithms, algorithms in cheminformatics. Computer language: C++

**Objective**
Development of programming skills and craftsmanship in order to be able to deal with the complexity of computer applications in chemistry.
Content
Introduction to algorithms (special focus chemistry):
Design of algorithms, data structures, search and sort algorithms, graphs, numerical algorithms, algorithms in cheminformatics
Computer language: C++

Lecture notes
Script (in English) will be available

Literature

C++ programming:

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

Materials Science

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<tr>
<td>529-0947-00L</td>
<td>Basic Polymer Synthesis</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>A. D. Schlüter</td>
</tr>
</tbody>
</table>

Abstract
Chain-growth polymerizations (anionic, cationic, Ziegler/Natta, ROMP, radical, NMP, ATRP, RAFT), mechanistic details including how to render a polymerization “living”, recent developments, and important examples.

Objective
The students should gain an overview of important polymerization procedures, learn how to deal with chemical structures and reactivities, and be able to suggest reasonable synthetic pathways to a given polymer structure. Aspects like achievable molar masses in dependence of the method used and structure perfection play a role throughout.

Content
I. Anionic polymerization
   1. General
   2. Living polymerization
   3. Group transfer polymerization (GTP)
   4. Some recent developments

II. Cationic polymerization
   1. General
   2. Some applications (macromonomer and telechelics)

III. Ziegler/Natta- and metallocene polymerization
   1. General
   2. Mechanism
   3. Some applications

IV. Ring-opening metathesis polymerization
   1. Comments on history
   2. Monomers, catalysts, polymer structures
   3. Mechanism, direct NMR monitoring
   4. Termination
   5. Examples

V. Controlled radical polymerization
   1. Nitroxide mediated polymerization (NMP)
   2. Atom transfer radical polymerization (ATRP)
   3. Reversible addition fragmentation chain transfer polymerization (RAFT)

For step-growth procedures and other topics (dendrimers, bottle-brushes, macrocycles, polyrotaxanes, topochemical polymerizations etc.) see Advanced Polymer Synthesis

Lecture notes
A script will not be provided. For all projections shown, however, paper copies will be distributed.

Literature
There is no specific literature recommendation. Numerous references will be provided for an easy access to the original literature.

Prerequisites / notice
The course will be taught in English. Complicated expressions will be explained in German. Questions can be asked in both languages. The examination will be in English; answers are acceptable in both languages.

PhD students who need recognized credit points are required to pass the written exam.

Environmental Chemistry

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0037-01L</td>
<td>Introduction to Environmental Chemistry and Ecotoxicology</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>K. Fenner, C. Bogdal, J. Hollender</td>
</tr>
</tbody>
</table>

Abstract
Production and use of chemicals also introduces them into the environment. This course introduces chemistry students to environmental chemistry, ecotoxicology and trace analysis.
Partitioning behavior and reactions of organic pollutants in the environment. Biodegradation, bioavailability and bioaccumulation. Ecotoxicological effects at the molecular level. Aspects of chemical trace analysis.

Objective
Goals:
* The students develop an understanding of the processes that govern the fate and effects of chemicals in the environment.
* The students know a number of methods for estimating the fate and effect of environmental pollutants. They recognize the relevant processes affecting a given compound and know how to use appropriate estimation methods for their quantification.
Content

Part I: Fate of Chemicals in the Environment:
Relevant environmental compartments and how chemicals reach the environment.
Partitioning in the environment:
- Meaning of vapor pressure, water solubility and air-water partition coefficient for environmental behavior
- Octanol-water partition coefficient as surrogate for partitioning into biological systems
- Influence of temperature and pH on partitioning
- Global distribution of semi-volatile chemicals
- Molecular interactions that govern partitioning
- Sorption to natural surfaces, partitioning into natural organic matter
Chemical and photochemical transformation reactions
Microbial transformation processes in the environment

Part II: Effects of chemicals in the environment
Biological test systems for assessing ecotoxicological effects
Endpoints of toxicity assessment:
- Acute and chronic toxicity, effects on reproduction
- Dose-response modeling
Bioavailability and bioaccumulation:
- Bioconcentration, biomagnification, food chain accumulation
- Active and passive uptake mechanisms
Molecular mechanisms of toxicity in cells:
- Baseline toxicity
- Specific toxicity (Examples: Inhibition of photosynthesis, neurotoxicity, including AchEsterase, ion channels etc.)
- Oxidative stress
- Genotoxicity

Part III: Specific aspects of trace analysis in the environment (soil, water, air)
Planning of analytical strategy and sampling
Enrichment procedures
Separation and detection
Quantification, screening for unknowns

Lecture notes
Copies of the slides and some articles are distributed

Literature

701-1233-00L
Stratospheric Chemistry

Abstract

Objective
The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.

Content
Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and thermo molecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the oxygen species with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chloride activation.

Lecture notes
Documents are provided in the contact hours.

Literature

Prerequisites / notice
Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.

701-1233-00 V starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-CHAB.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Chemistry Bachelor - Key for Type

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<th>Code</th>
<th>Type</th>
<th>Note</th>
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<tr>
<td>O</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Suitable for doctorate</td>
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### Key for Hours

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<td>V</td>
<td>lecture</td>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course.

Objective
- Understand research methods used in the empirical educational sciences
- Understand pedagogically relevant findings from the empirical educational sciences

Prerequisites / notice
Für eine reibungsfreie Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

---

**Chemistry Teaching Diploma**

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

### Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects  W Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
<td></td>
<td></td>
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<tr>
<td>Abstract</td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<tr>
<td>Objective</td>
<td>- Get to know cognitively activating instructions in MINT subjects - Get information about recent literature on learning and instruction</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Für eine reibungsfreie Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td>Abstract</td>
<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<tr>
<td>Objective</td>
<td>- Understanding of research methods used in the empirical human sciences - Getting to know intelligence tests - Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td>Abstract</td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<tr>
<td>Objective</td>
<td>- Understand research methods used in the empirical educational sciences - Understand and critically examine information from scientific journals and media - Understand pedagogically relevant findings from the empirical educational sciences</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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<td></td>
<td>The successful completion of both course no. 851-0240-00L &quot;Menschliches Lernen (EW 1)&quot; and course no. 851-0238-01L &quot;Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)&quot; is a necessary prerequisite for this course.</td>
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<tr>
<td>Abstract</td>
<td>In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<tr>
<td>Objective</td>
<td>- The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction) Learning goals include: - Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples. - Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction. - Participants can design and conduct a study that is relevant for answering their research question. - Participants can summarize and evaluate the main results from a study in the field of learning and instruction, with regard to the research question being asked.</td>
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</tbody>
</table>

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**Subject Didactics in Chemistry**

Important: You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in

In Autumn Semester 2015, the following courses are offered:

### Mentored Work Subject Didactics Chemistry A

**Abstract**

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**

The objective is for the students:

- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**

Thematische Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen


**Lecture notes**

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

**Literature**

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

**Prerequisites / notice**

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

### Mentored Work Subject Didactics Chemistry B

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**

The objective is for the students:

- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**

Thematische Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen


**Lecture notes**

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

**Literature**

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

**Prerequisites / notice**

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

### Subject Didactics Chemistry I

**Abstract**

Implementing findings from research into teaching and learning for chemistry lessons and coverage of subject-specific teaching and learning specialities.

**Objective**

- Among other things, students are put in a position where they can
  - divide up the subject matter into contents that can be learned by heart or accessed intellectually, and communicate these contents.
  - break down technically complex contents to the right level for a class and still present these in a stringent, error-free manner in their simplified form.
  - establish which subject matter can be presented with which teaching techniques and methods that have been recognised as efficient in teaching terms, and adapt these tools to the learning content in question.
  - plan school experiments, incorporate them in lessons, perform them in accordance with all the rules of the art, and also evaluate them in a beneficial manner.
  - assess pupils’ prior knowledge, clarify it in greater detail and take it into account for planning lessons.
  - design a sequential curriculum suitable for the levels in question and put it into practice.
  - reliably identify stumbling blocks in the contents and get round these.

**Content**

Schwerpunkte im ersten Studiensemester bilden die folgenden Themen:

- Auswahl gymnasiumsrelevanter Lerninhalte
- Modellbegriff in den Naturwissenschaften, insbesondere der Chemie
- Sprache und Fachsprache im Chemieunterricht
- Wechselwirkung zwischen Beobachtungen in der realen Welt und Deutungsversuchen auf der Modell-Ebene
- Interdisziplinarität mit Biologie, Mathematik und Physik
- Leistungserhebung und -beurteilung im Theorie- und Laborunterricht
- Atommodelle und chemische Bindung
- Mathematische Beschreibung chemischer Systeme (z.B. Stöchiometrie und Gleichgewichtssysteme)
- Auswahl, Konzeption, Einbettung, Vorbereitung, Durchführung, Nachbereitung und Auswertung von Demonstrations- und Schüler-Experimenten

**Lecture notes**

U. Wuthier: Chemie unterrichten, Eine Didaktik für Höhere Schulen.

### Professional Training in Chemistry

**Important:** You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0966-00L</td>
<td>Introductory Internship Chemistry ■</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>A. Baertsch</td>
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<tr>
<td></td>
<td>Simultaneous enrolment in Subject Didactics Chemistry I ■</td>
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<td></td>
<td>- course 529-0950-00L - is compulsory.</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.</td>
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<td><strong>Objective</strong></td>
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<td>Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.</td>
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<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<td></td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
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<tr>
<td>529-0964-00L</td>
<td>Teaching Internship Chemistry ■</td>
<td>O</td>
<td>8 credits</td>
<td>17P</td>
<td>A. Baertsch</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.</td>
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<td></td>
<td>- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.</td>
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<td>- They acquire the skills of the teaching trade.</td>
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<td>- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.</td>
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<td>- They learn to assess pupils’ work.</td>
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<td>- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.</td>
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<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<td></td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td></td>
<td>Findet in der Regel am Schluss der Ausbildung, vor Ablegung der Prüfungslektionen statt.</td>
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</tr>
<tr>
<td>529-0965-00L</td>
<td>Teaching Internship Chemistry II ■</td>
<td>W</td>
<td>4 credits</td>
<td>9P</td>
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</tr>
<tr>
<td></td>
<td>Teaching Internship for students upgrading TC to Teaching Diploma.</td>
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<td><strong>Abstract</strong></td>
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<td>This is a supplement to the Teaching Internship required to obtain a “Lehrdiplom” in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln erfassen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbare (Fach-)Wissen zu erwerben.</td>
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<td><strong>Content</strong></td>
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<tr>
<td>529-0955-00L</td>
<td>Professional Exercises: Experiments in Teaching Chemistry ■</td>
<td>O</td>
<td>2 credits</td>
<td>4V</td>
<td>A. Baertsch</td>
</tr>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>This course unit introduces students to the technique of conducting experiments in chemistry lessons. It covers didactic, technical, safety-related and presentation aspects.</td>
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</tbody>
</table>
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-based skills they have acquired in the course of their training. They:

- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Abstract

On the basis of a specified topic, the candidate shows that they are in a position

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content

Die Studierenden erfahren das Lektionsthema in der Regel eine Woche vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortag um 12 Uhr den beiden Prüfungsexperten ein.

will mark the conclusion of the teacher training program in Chemistry.

Objectives

- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Abstract

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Objective

On the basis of a specified topic, the candidate shows that they are in a position

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content

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Abstract

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Objective

On the basis of a specified topic, the candidate shows that they are in a position

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.
Selected topics in general chemistry:
1) The language of chemistry
2) Chirality and stereochemistry
3) Oxidation of water
4) Chemistry of the atmosphere

In this course, participants acquire extended and more in-depth knowledge of selected chemistry topics. The selection is based to a large extent on the partial aspects of chemistry that are typically taught at high school. By gaining a broader understanding, teachers are put in a position where they can comprehend the topics that are to be taught in a wider and, to some extent, unconventional context and critically process these in respect of their teachability and learnability. At the same time, interrelationships between the classical sub-disciplines of chemistry are highlighted, along with the unique features of chemistry as one of the central natural sciences.

Content:
1) The language of chemistry; Concepts, formulas, aesthetics, and philosophical aspects
2) Chirality and stereochemistry; Selected aspects, origin of biomolecular chirality, inorganic chemistry
3) Cosmochemistry
4) Chemistry of the atmosphere

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

Content:
Thematische Schwerpunkte:

Lernformen:

Lecture notes / Literature:
Foliensätze und ausgewählte Literatur werden zur Verfügung gestellt.
Ausgewählte Artikel aus der Primärliteratur werden vorgestellt, kommentiert und zur Lektüre empfohlen.

Prerequisites / notice:
FV A (gelesen im Frühjahrsemester) und FV B (gelesen im Herbstsemester) bauen nicht aufeinander. Die Reihenfolge der Belegung ist somit indifferenter.

529-0962-01L Mentored Work Specialised Courses in the Respective O 2 credits 4A R. Ciorciaro
Subject with an Educational Focus Chemistry B

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

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

Content:
Thematische Schwerpunkte:

Lernformen:

Lecture notes / Literature:
Foliensätze und ausgewählte Literatur werden zur Verfügung gestellt.
Ausgewählte Artikel aus der Primärliteratur werden vorgestellt, kommentiert und zur Lektüre empfohlen.

Prerequisites / notice:
FV A (gelesen im Frühjahrsemester) und FV B (gelesen im Herbstsemester) bauen nicht aufeinander. Die Reihenfolge der Belegung ist somit indifferenter.

► Compulsory Elective Courses

see Compulsory Elective Courses Teaching Diploma

► Additional Requirements (ETH-Masterstudents in Chemical + Bioeng.)

►► Part 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0200-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>16 credits</td>
<td>16A</td>
<td>Professors</td>
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<tr>
<td>Abstract</td>
<td>In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.</td>
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<tr>
<td>Objective</td>
<td>Students are accustomed to scientific work and they get to know one specific research field.</td>
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| 529-0132-00L | Inorganic Chemistry III: Organometallic Chemistry and Homogeneous Catalysis | O    | 4 credits | 3G | A. Togni, A. Mezzetti   |
| Abstract     | Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbonylation, C-C bond-forming and related reactions. |
| Objective    | Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to homogeneous catalysis. |
| Content      | Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbonylation, C-C bond-forming and related reactions. |

| 529-0232-00L | Organic Chemistry III: Introduction to Asymmetric Synthesis | O    | 4 credits | 3G | E. M. Carreira          |
| Abstract     | Methods of Asymmetric Synthesis              |
| Objective    | Understanding of the basic principles of diastereoselective synthesis |
| Content      | Conformational analysis: acyclic and cyclic systems; Diastereoselective sigmatropic rearrangements; Diastereoselective Carbonyl addition reactions: Cram- and Felkin-Anh models, carbonyl Lewis acid interactions, chelate controlled reactions; chemistry of enolates, selective formation; asymmetric enolate alkylation; aldol reactions, allyl- and crotyl-metal chemistry; cyclisations, Baldwin rules; Diastereoselective olefin functionalization: hydroboration, dihydroxylation, epoxidation. |

| 529-0241-00L | Advanced Methods and Strategies in Synthesis | O    | 7 credits | 3G | J. W. Bode               |
| Abstract     | Advanced Modern Methods and Strategies in Synthesis |
| Objective    | Knowledge of modern methods in asymmetric stereocontrol, enantioselective catalysis, and organic reaction mechanisms. |
Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precedents, and emerging topics will be emphasized.

Lecture notes will be provided in class and online

**Literature**

Suggesting Textbooks


### Part 2

*see Chemistry Master > Electives*

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

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

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Organic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>529-0241-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>J. W. Bode</td>
</tr>
<tr>
<td>Abstract</td>
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<tr>
<td>Objective</td>
<td>Knowledge of modern methods in asymmetric stereocontrol, enantioselective catalysis, and organic reaction mechanisms.</td>
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<td>Content</td>
<td>Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.</td>
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<td>Lecture notes</td>
<td>will be provided in class and online</td>
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<td>Literature</td>
<td>Suggesting Textbooks</td>
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<td>Prerequisites/notice</td>
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## Physical Chemistry

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<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>529-0433-00L</td>
<td>Advanced Magnetic Resonance</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>B. H. Meier, M. Ernst</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course is for advanced students and covers selected topics from magnetic resonance spectroscopy. This year, the lecture will introduce and discuss the theoretical foundation of high-resolution solid-state NMR under magic-angle spinning.</td>
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<tr>
<td>Objective</td>
<td>The aim of the course is to familiarize the students with the basic concepts of high-resolution solid-state NMR. Starting from the mathematical description of spin dynamics, important building blocks for multi-dimensional experiments are discussed to allow students a better understanding of modern solid-state NMR experiments.</td>
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<td>The basic principles of NMR in solids will be introduced. After the discussion of basic tools to describe NMR experiments, basic methods and experiments will be discussed, e.g., magic-angle spinning, cross polarization, decoupling, and recoupling experiments. Such basic building blocks allow a tailoring of the effective Hamiltonian to the needs of the experiment. These basic building blocks can then be combined in different ways to obtain spectra that contain the desired information.</td>
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<tr>
<td>Lecture notes</td>
<td>A script which covers the topics will be distributed in the lecture and will be accessible through the web page <a href="http://www.ssnmr.ethz.ch/education/">http://www.ssnmr.ethz.ch/education/</a></td>
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## Compensatory Courses

### Physical Chemistry

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>529-0445-00L</td>
<td>Advanced Optics and Spectroscopy</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>R. Signorell</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course will cover selected topics from magnetic resonance spectroscopy. This year, the lecture will introduce and discuss the theoretical foundation of high-resolution solid-state NMR under magic-angle spinning.</td>
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<td>Content</td>
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</table>
Abstract
This course provides an introduction to the interaction of light with nano- and microparticles followed by an overview of applications of current interest. Examples range from nanoparticles for medical applications and sensing to the role of the interaction of solar radiation with aerosol particles and cloud droplets for the climate.

Objective
The students will be introduced to the basic concepts of the interaction of light with nano- and microparticles. The combination of basic concepts with different applications will enable students to apply their knowledge to new problems in various fields where nanoscale objects play a role.

Content
Light interacts surprisingly differently with small particles than with bulk or with gas phase materials. The first part of the course provides a basic but rigorous introduction into the interaction of light with nano- and microparticles. The emphasis is on the classical treatment of absorption and scattering of light by small particles. The strengths and limits of this conventional approach will be discussed. The second part of the course is devoted to a broad range of applications. Here topics include: Plasmon resonances in metallic systems, metallic dielectric nanoparticles for medical applications, the use of lasers for optical trapping and characterization of single particles, vibrational excitons in dielectric nanoparticles, interaction of light with aerosol particles and cloud droplets for remote sensing applications and climate predictions, characterization of ultrtrane aerosol particles by photoemission using velocity map imaging.

Lecture notes
will be distributed during the course

Literature
Basics: Absorption and Scattering of Light by Small Particles, C. F. Bohren and D. R. Huffman, John Wiley & Sons, Inc.

Applications: References will be provided during the course.

Inorganic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0143-00L</td>
<td>Inorganic and Organometallic Polymers</td>
<td>O</td>
<td>7 credits</td>
<td>3G</td>
<td>H. Grützmaer, J. Grützmaer</td>
</tr>
<tr>
<td>Abstract</td>
<td>1. Introduction: What are Inorganic Polymers</td>
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<td></td>
<td>2. Polyphosphazenes</td>
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<td></td>
<td>3. Polysiloxanes</td>
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<td></td>
<td>4. Organometallic Polymers</td>
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<td>5. Dendritic Molecules</td>
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<td></td>
<td>6. Introduction to Inorganic Materials</td>
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<tr>
<td>Objective</td>
<td>Understanding of the current literature in the field of inorganic polymers and materials.</td>
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<tr>
<td>Lecture notes</td>
<td>A manuscript will be distributed to the participants of the course.</td>
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<tr>
<td>Literature</td>
<td>Script and recent original literature indicated in the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Basis for the understanding of this lecture are the courses Allgemeine Chemie 1&amp;2, Anorganische Chemie 1: Übergangsmetallchemie (Dozent Mezzetti).</td>
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Organic Chemistry

<table>
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<tr>
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<tbody>
<tr>
<td>529-0243-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>J. W. Bode</td>
</tr>
<tr>
<td>Abstract</td>
<td>Knowledge of modern methodologies in asymmetric stereoccontrol, enantioselective catalysis, and organic reaction mechanisms.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.</td>
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<tr>
<td>Content</td>
<td>Methods leading to desired transformations, and insight into reaction mechanisms is exemplified. Relations between retrosynthetic analysis of target structures, synthetic methods and their combination in a synthetic strategy.</td>
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<tr>
<td>Lecture notes</td>
<td>A printed script are handed out in the course. This material is also available for download from the web page of the course (as pdf files).</td>
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<tr>
<td>Literature</td>
<td>Suggesting Textbooks</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Each participant is expected to contribute to a 30 min. seminar (prepared by groups of 2-4 students), presented in the last weeks of the semester.</td>
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Physical Chemistry

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<th>Hours</th>
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<tr>
<td>529-0043-00L</td>
<td>Advanced Magnetic Resonance</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>B. H. Meier, M. Ernst</td>
</tr>
<tr>
<td>Abstract</td>
<td>The complex relation between structural analysis, methods leading to desired transformations, and insight into reaction mechanisms is exemplified. Relations between retrosynthetic analysis of target structures, synthetic methods and their combination in a synthetic strategy.</td>
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<tr>
<td>Objective</td>
<td>Extension and deepening of the knowledge in organic synthesis.</td>
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<tr>
<td>Content</td>
<td>Concepts of the planning of organic synthesis (strategy and tactics), retrosynthetic analysis. Structure-reactivity relation in the context of the synthesis of complex molecules.</td>
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<tr>
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<tr>
<td>Prerequisites / notice</td>
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</table>
Abstract
The course is for advanced students and covers selected topics from magnetic resonance spectroscopy. This year, the lecture will introduce and discuss the theoretical foundation of high-resolution solid-state NMR under magic-angle spinning.

Objective
The aim of the course is to familiarize the students with the basic concepts of high-resolution solid-state NMR. Starting from the mathematical description of spin dynamics, important building blocks for multi-dimensional experiments are discussed to allow students a better understanding of modern solid-state NMR experiments.

Content
The basic principles of NMR in solids will be introduced. After the discussion of basic tools to describe NMR experiments, basic methods and experiments will be discussed, e.g., magic-angle spinning, cross polarization, decoupling, and recoupling experiments. Such basic building blocks allow a tailoring of the effective Hamiltonian to the needs of the experiment. These basic building blocks can then be combined in different ways to obtain spectra that contain the desired information.

Lecture notes
A script which covers the topics will be distributed in the lecture and will be accessible through the web page [http://www.ssnmr.ethz.ch/education/](http://www.ssnmr.ethz.ch/education/)

529-0445-00L
Advanced Optics and Spectroscopy

W 7 credits 3G  R. Signorelli

Abstract
This course provides an introduction to the interaction of light with nano- and microparticles followed by an overview of applications of current interest. Examples range from nanoparticles for medical applications and sensing to the role of the interaction of solar radiation with aerosol particles and cloud droplets for the climate.

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The students will be introduced to the basic concepts of the interaction of light with nano- and microparticles. The combination of basic concepts with different applications will enable students to apply their knowledge to new problems in various fields where nanoscale objects play a role.

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Lecture notes
will be distributed during the course

Literature
Basics: Absorption and Scattering of Light by Small Particles, C. F. Bohren and D. R. Huffman, John Wiley & Sons, Inc.

Applications: References will be provided during the course.

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## Analytical Chemistry

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<tr>
<td>529-0043-00L</td>
<td>Analytical Strategy</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>R. Zenobi, M. Badertscher,</td>
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<td>P. S. Dittrich, D. Günther</td>
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</table>

Abstract
Problem-oriented development of analytical strategies and solutions.

Objective
Ability to create solutions for particular analytical problems.

Content
Individual development of strategies for the optimal application of chemical, biochemical, and physico-chemical methods in analytical chemistry solving predefined problems. Experts from industry and administration present particular problems in their field of activity.

Principles of sampling.

Design and application of microanalytical systems.

Lecture notes
Copies of problem sets and solutions will be distributed free of charge

Prerequisites / notice
Prerequisites:
529-0051-00 "Analytical Chemistry I (3. Semester)"
529-0058-00 "Analytical Chemistry II (4. Semester)"
(or equivalent)

529-0049-00L | Analytical Methods for Characterization of Nanoparticles and Nanomaterials | W    | 2    | 2G    | C. Latkoczy

Abstract
Introduction to modern analytical methods used to fully characterize and identify nano-engineered materials and systems.

Objective
Understanding of analytical concepts used in nanotechnology. In-depth knowledge of most important methods used in industry and research. Introduction to selected industrial applications. Basic knowledge of production mechanisms of nano-engineered materials.

Content
Nanotechnology is the basis of many main technological innovations of the 21st century. After more than twenty years of research, nanotechnologies are now increasingly employed for commercial use: they are used in hundreds of everyday consumer products, such as cosmetics, food, automotive, electronics and medical products. Nanoparticles can contribute to stronger, lighter, cleaner, smarter, better, etc. products. Besides these positive effects, relatively little is still known about potential health and environmental effects and risks of such small nano-sized particles. Therefore, a lot of different industry customers are forced nowadays to monitor and regulate the size and concentration of nanoparticles in their nano-enabled products.

Above and beyond these regulatory requirements, most industries employing nanoparticles need to be able to online measure nanoparticles to meet their requirements towards quality control and production efficiency. All these requirements demand new precise, accurate, fast and innovative analysis methods to fully characterize nanoparticles in real-time and during the manufacturing process.

Lecture notes
Lecture notes will be provided

Prerequisites / notice
Prerequisites: 529-0051-00 "Analytical Chemistry I (3. Semester)", 529-0058-00 "Analytical Chemistry II (4. Semester)" (or equivalent)

## Biological Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0733-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
</tbody>
</table>

Abstract
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Objective
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Content
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Lecture notes
A script will not be handed out.

Literature
General:

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

---
Chemical Aspects of Energy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Wokaun, A. Steinfeld</td>
</tr>
</tbody>
</table>

Abstract
Scenarios for world energy demand and CO₂ emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO₂ sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO₂ emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed during the course.

Literature

Prerequisites / notice
Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

Chemical Crystallography

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0029-00L</td>
<td>Structure Determination</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>M. D. Wörle, N. Trapp</td>
</tr>
</tbody>
</table>

Abstract
Advanced X-ray crystal structure analysis

Objective
To gain a deeper understanding of crystal structure determination principles and practice by X-ray diffraction and the evaluation of results.

Content
Review of principles of diffraction and instrumentation, unit cells, lattices, and symmetry. Inorganic structural chemistry: sphere packings, ionic crystals, covalent networks, intermetallic compounds. Overview of powder diffraction and application of crystal chemistry for structure analysis of polycrystalline phases. Working safely with X-rays, crystal growth, selection and mounting, data collection strategies, data reduction, corrections for absorption, extinction and Lp, advanced structure solution technique and techniques: Patterson function, heavy atom technique, Fourier methods, direct methods. Structure modeling and refinement, disorder, twinning, false symmetry, interpretation of anisotropic shift parameters. Determination of absolute configuration, interpretation of results and scope of chemically useful information, validation and publication of results, critical evaluation of published crystal structures.

Lecture notes
Lecture notes will be distributed during the course.

Literature
- Main references
  - J.D. Dunitz, "X-ray Analysis and the Structure of Organic Molecules", 1995, Verlag HCA.

Prerequisites / notice
Students will conduct the computational exercises and examples of structure solution and refinement on personal computers.

Chemical Technology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W</td>
<td>6</td>
<td>3V</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Lecture notes Handsout during the course.

Computational Chemistry

Number Title Type ECTS Hours Lecturers
529-0003-00L Advanced Quantum Chemistry W 7 credits 3G M. Reiher, S. Knecht

Abstract Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer. Examples are:
* Operators derived from principles of relativistic quantum mechanics
* Relativistic effects + methods of relativistic quantum chemistry
* Open-shell molecules + spin-density functional theory
* New electron-correlation theories

Objective The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

The relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum-chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of predefined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also re-examining the world of quantum chemistry, namely density functional theory, with an eye towards open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

Content
1) Introductory lecture: basics of quantum mechanics and quantum chemistry
2) Einstein's special theory of relativity and the (classical) electromagnetic interaction of two charged particles
3) Klein-Gordon and Dirac equation: the Dirac hydrogen atom
4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
6) Relativistic effects in chemistry and the emergence of spin
7) Spin in density functional theory
8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
9) Quantum chemistry without the Born-Oppenheimer approximation

Lecture notes A set of detailed lecture notes will be provided, which will cover the whole course.

Literature
2) F. Schwabl: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997 [english version available: F. Schwabl, Advanced Quantum Mechanics]
3) R. McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992

Note also the standard textbooks:
A) A. Szabo, N.S. Ostlund. Introduction. Springer-Verlag, 1997
B) I. N. Levine. Quantum Chemistry. Pearson

Prerequisites / notice

Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

Computer Simulation in Chemistry, Biology and Physics

Number Title Type ECTS Hours Lecturers
529-0004-00L Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

Objective Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes Available (copies of powerpoint slides distributed before each lecture)

Literature See: www.csms.ethz.ch/education/CSCBP
Materials Science

Course: Introduction to Macromolecular Chemistry (529-0941-00L) will be given in spring semester

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

Abstract
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Objective
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Content
This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

Lecture notes
English

Literature

Enri: Aberration-corrected imaging in transmission electron microscopy, Imperial College Press (2010, and 2nd ed. 2015)

Environmental Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0745-00L</td>
<td>General and Environmental Toxicology</td>
<td>W</td>
<td>7</td>
<td>3V</td>
<td>M. Arand, H. Nägeli, B. B. Steiger, I. Werner</td>
</tr>
</tbody>
</table>

Abstract
Toxicokinetic and toxicodynamic aspects of xenobiotic interactions with cellular structures and mechanisms. Toxic responses at the level of organs (immune-, neuro-, reproductive and genotoxicity) and organisms. Introduction into developmental toxicology and ecotoxicology.

Objective
Understanding of the impact of chemicals on biological systems; evaluation of the effects from different biomedical perspectives.

Content
Explanation of important interactions between xenobiotic chemicals and cellular structures such as membranes, enzymes, and nucleic acids. Relevance of intake, distribution, excretion, and biochemical transformation processes. Relevance of mixtures. Explanation of important modes of toxic action such as immunotoxicity, neurotoxicity, reproduction toxicity, genotoxicity based on examples of certain xenobiotics and their effects on important organs.

Lecture notes
Course material will be handed out as the lectures progress

Literature
Textbooks of pharmacology and toxicology (cf. list in course material)

Prerequisites / notice
Educational basis: basic chemistry, biology and biochemistry

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>529-0047-00L</td>
<td>Risk Assessment of Chemicals</td>
<td>W</td>
<td>7</td>
<td>6A</td>
<td>C. Bogdal, C. A. Baumel, K. Hungerbühl</td>
</tr>
</tbody>
</table>

Abstract
Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.

Objective
Projects on chemical assessment with the focus on the following aspects:

* Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
* Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
* Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.

Content
Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.

* Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Lecture notes
See recommended literature.

Literature

Prerequisites / notice
Co-operation with chemical companies.

Laboratory Courses and Research Projects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0200-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>16</td>
<td>16A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0201-00L</td>
<td>Research Project II</td>
<td>O</td>
<td>17</td>
<td>17A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.
Students are accustomed to scientific work and they get to know one specific research field.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0739-00L</td>
<td>Biological Chemistry A: Technologies for Directed Evolution of Enzymes</td>
<td>W</td>
<td>16 credits</td>
<td>16P</td>
<td>P. A. Kast, D. Hilvert</td>
</tr>
</tbody>
</table>

Before online enrolment, it is mandatory to sign up directly with P. Kast, no later than 2 weeks prior to start of autumn semester.

Further information to registration and work hours: [www.protein.ethz.ch/kast/praktikum.html](http://www.protein.ethz.ch/kast/praktikum.html)

Abstract

During this semester course, methodologies will be taught for biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains.

Objective

All technologies used for the experiments will be explained to the students in practice with the goal that they will be able to independently apply them for the course project and in future research endeavors. After the course, an individual report about the results obtained has to be prepared.

Content

This class conducts and supports experiments for a specifically designed genuine research project. We will carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. The relevant technologies will be taught to the students, such as the preparation of competent cells, production and isolation of DNA fragments, transformation of gene libraries, and DNA sequencing. The course participants will generate a variety of different variants of a chorismate mutase. Individual enzyme catalysts will be purified and subsequently characterized using several different spectroscopic methods. The detailed chemical-physical analyses include determination of the enzymes’ kinetic parameters, their molecular mass, and the integrity of the protein structure. The students will present the results obtained from their individual evolution experiments at the end of the semester. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst.

Lecture notes

The necessary documents and protocols will be distributed to the participants during the course.

Literature

- General literature to "Directed Evolution" and chorismate mutases, e.g.:

Further literature will be indicated in the distributed script.

Prerequisites / notice

- This laboratory course will involve experiments that require a tight schedule and (sometimes) long (!) working days.
- The projects of this course are tightly linked to the ones of the Biology BSc course "Biological Chemistry B: New Enzymes from Directed Evolution Experiments", which takes place as a block course during the month of November. There will be joint lectures for the participants of both courses during that time. The teaching language is English.
- The number of participants for the laboratory class is limited. It is mandatory to sign up for the course directly with P. Kast at latest 2 weeks prior to the start of the fall semester. A valid registration is considered a commitment for attendance of the entire semester course, as involved material orders and experimental preparations are necessary and, once the class has started, the flow of the experiments must not be interrupted by individual absences. In case of an emergency, please immediately notify P. Kast.
- For more information, see also [http://www.protein.ethz.ch/kast/praktikum.html](http://www.protein.ethz.ch/kast/praktikum.html) or contact P. Kast directly (HCI F 333, Tel. 044 632 29 08, kast@org.chem.ethz.ch).

Compulsory Electives in Humanities, Social and Political Sciences

- Recommended GESS compulsory elective courses (Type B) for D-CHAB.
- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses ETH/UEZH

Master Thesis

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0500-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>20 credits</td>
<td>43D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Duration of the Master's Thesis 16 weeks.

Abstract

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

Objective

In the Master Thesis students prove their ability to independent, structured and scientific working.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0051-AAL</td>
<td>Analytical Chemistry I</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>D. Günther, R. Zenobi</td>
</tr>
</tbody>
</table>

Enrolment only for MSc students who need this course as additional requirement.

Abstract

Introduction into the most important spectroscopical methods and their applications to gain structural information.

Objective

Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications.
Eligible for credits and recommended in independent project.

Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative addition, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbonylation, C-C bond-forming and related reactions.

Lecture notes
Script will be for the production price.

- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice
Excercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 “Instrumental analysis of organic compounds” (4th semester) is recommended.

529-0122-AAL Inorganic Chemistry II
Enrollment only for MSc students who need this course as additional requirement.

Abstract
The lecture is based on Inorganic Chemistry I and addresses an enhanced understanding of the symmetry aspects of chemical bonding of molecules and translation polymers, i.e. crystal structures.

Objective
The lecture is based on Inorganic Chemistry I and addresses an enhanced understanding of the symmetry aspects of chemical bonding of molecules and translation polymers.

Content
Symmetry aspects of chemical bonding, point groups and representations for the deduction of molecular orbitals, energy assessment for molecules and solids, Sanderson formalism, derivation and understanding of band structures, densities of states, overlap populations, crystal symmetry, basic crystal structures and corresponding properties, visual representations of crystal structures.

Lecture notes
Additional information is available on the internet at:
http://www.ac.ethz.ch/
user: aach
password: jsenpw

Literature

Prerequisites / notice
Requirements: Inorganic Chemistry I

529-0132-AAL Inorganic Chemistry III: Organometallic Chemistry and E-Homogeneous Catalysis
Enrollment only for MSc students who need this course as additional admission requirement.

Abstract
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbonylation, C-C bond-forming and related reactions.

Objective
Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to homogeneous catalysis.

Content
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbonylation, C-C bond-forming and related reactions.

Literature
A more comprehensive standard work on organometallic chemistry. Several chapters written by various authors, partly specialized review-article style.

Chemistry Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

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

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Chemical and Bioengineering Master

Core Subjects

Bioengineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0837-00L</td>
<td>Biomicrofluidic Engineering</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>A. de Mello</td>
</tr>
</tbody>
</table>

Abstract
Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

Objective
In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Content
Specific topics in the course include, but not limited to:

1. Theoretical Concepts
   - Features of mass and thermal transport on the microscale
   - Key scaling laws
2. Microfluidic Device Manufacture
   - Conventional lithographic processing of rigid materials
   - Soft lithographic processing of plastics and polymers
3. Mass fabrication of polymeric devices
   - Unit operations and functional components
   - Analytical separations (electrophoresis and chromatography)
4. Chemical and biological synthesis
   - Sample pre-treatment (filtration, SPE, pre-concentration)
   - Molecular detection
5. Design Workshop
   - Design of microfluidic architectures for PCR, distillation & mixing
6. Contemporary Applications in Biological Analysis
   - Microarrays
   - Cellular analyses (single cells, enzymatic assays, cell sorting)
   - Proteomics
7. System integration
   - Applications in radiochemistry, diagnostics and high-throughput experimentation

Lecture notes
Lecture handouts, background literature, problem sheets and notes will be provided electronically.

Polymers

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0615-00L</td>
<td>Polymerization Reaction and Colloid Engineering</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>M. Morbidelli</td>
</tr>
</tbody>
</table>

Abstract

Objective
Introduce the students to the design of polymerization reactors for the production of polymers with molecular characteristics suitably tuned for specific applications. This includes the post-treatment of polymer latexes and the analysis of their colloidal behavior.

Content
The aim of the course is to provide the tools needed for the understanding of the fundamental processes and the design of the industrial units involved in the production of polymeric materials and in the post-treatment of polymer colloids. In particular, the following topics are discussed: Physico-chemical characterization of polymers and description of the polymerization processes. Kinetics of free-radical polymerization and use of population balance models. Production of homo- and co-polymers with controlled characteristics in terms of molecular weight distribution and chain composition distribution. Living polymerizations. Design of polymerization reactors and the thermal runaway problem. Kinetics and control of emulsion polymerization. The radical segregation problem. Surfactants and colloidal stability. Aggregation kinetics and aggregate structure in conditions of diffusion and reaction limited aggregation. The role of shear conditions on aggregation and breakage kinetics and on the aggregate structure. Modeling and design of colloid aggregation processes.

Lecture notes
Skripts are available on the 'Polymerization Reaction and Colloid Engineering' web page of the Morbidelli-group, vide the given link for details.

Literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0619-00L</td>
<td>Chemical Product Design</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>W. J. Stark</td>
</tr>
</tbody>
</table>

Abstract
The 'Chemical Product Design' course teaches students quantitative concepts to analyze, select and transform theoretical concepts from chemistry and engineering into valuable real-world products. Basic chemistry and chemical engineering knowledge is required (Diffusion, Thermodynamics, Kinetics,...).

Objective
This course starts with analyzing existing chemical needs and unmet technical challenges. We then develop the skills to critically analyze a specific chemical idea for a product, to rapidly test feasibility or chance for success and to eventually realize its manufacturing. The chemical engineering basics are then used to assess performance of products or devices with non-traditional functions based on dynamic properties (e.g. responsive building materials; personal medical diagnostics on paper strips). The course teaches the interface between laboratory and market with a specific focus on evaluating the chemical value of a given process or compound, and the necessary steps to pursue the resulting project within an entrepreneurial environment. We therefore extend the questions of process design ("how do we make something?") to the question of "what should we make?"
An exemplary literature list is provided below:


A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.
The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.

Objective

The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.

Content


Process economic evaluation: equipment sizing and costing, time value of money, cash flow calculations.

Batch Processes: scheduling, sizing and inventories.


Lecture notes

no script

Literature


Prerequisites / notice

Prerequisite: Thermal Unit Operations

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**Catalysis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0611-00L</td>
<td>Characterization of Catalysts and Surfaces</td>
<td>W+</td>
<td>7</td>
<td>3G</td>
<td>J. A. van Bokhoven, D. Ferri</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Basic elements of surface science important for materials and catalysis research. Physical and chemical methods important for research in surface science, material science and catalysis are considered and their application is demonstrated on practical examples.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Basic aspects of surface science. Understanding of principles of most important experimental methods used in research concerned with surface science, material science and catalysis.</td>
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<tr>
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<td><strong>Content</strong></td>
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<td></td>
<td>Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.</td>
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</tbody>
</table>

| 529-0617-00L | Catalysis Engineering | W+  | 7    | 3G    | J. Pérez-Ramírez |
|              | **Abstract**             |      |      |       |                          |
|              | The purpose of the "Catalysis Engineering" course is to provide students with tools that enable the optimal design of catalytic materials and reactor engineering concepts favoring more sustainable manufacturing processes within the chemical industry. |
|              | **Objective**            |      |      |       |                          |
|              | The course aims at illustrating, from conception to implementation, the design of sustainable catalytic processes by integration of the microlevel (catalyst), mesolevel (reactor), and macrolevel (process). The word "sustainable" implies intensified processes with an improved exploitation of raw materials, wider use of renewable feedstocks, reduction of energy consumption, and minimized environmental impact. By the use of modern case studies of industrial relevance, aspects of catalyst preparation and characterization, kinetics, mass and heat transport, and deactivation are discussed. Emphasis is put on understanding the interaction among these basic elements in order to select the optimal catalytic process. Since no textbooks covering this area are available at this time and the intention of this course is unique, the lectures will be based on own texts and journal articles. During the course, there will be specific topics addressed by industrial contributors. |
|              | **Content**              |      |      |       |                          |
|              | The following general aspects: |
|              | - Catalyst preparation and characterization |
|              | - Kinetics |
|              | - Mass and heat transport |
|              | - Selectivity |
|              | - Deactivation |
|              | will be demonstrated for modern catalytic materials and processes of industrial relevance such as: |
|              | - Chlorine recycling |
|              | - NOx abatement |
|              | - Chemoselective hydrogenations |
|              | - Hierarchical zeolite catalysts |
|              | - Syngas conversion |
|              | - Biomass to chemicals and fuels |

Lecture notes

The course material is based on an own script, journal articles, and slides.

Prerequisites / notice

It is assumed that students selecting this course are familiar with general concepts of catalysis, reactor design, and transport phenomena.

---

**Electives**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0113-00L</td>
<td>Applied Fluid Dynamics</td>
<td>W</td>
<td>4</td>
<td>2+1U</td>
<td>J.P. Kunsch</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Applied Fluid Dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment. Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water. There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed. The topics covered include: Emissions, fugitive emissions from pipelines and from container leaks, evaporation from pools and vaporization of gases, transport, and deactivation are discussed. Emphasis is put on understanding the interaction among these basic elements in order to select the optimal catalytic process. Since no textbooks covering this area are available at this time and the intention of this course is unique, the lectures will be based on own texts and journal articles. During the course, there will be specific topics addressed by industrial contributors.</td>
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</tbody>
</table>

Lecture notes

not available

Prerequisites / notice

Requirements: successful attendance at lectures "Fluiddynamik I und II", "Thermodynamik I und II"
151-0109-00L Turbulent Flows W 4 credits 2V+1U P. Jenny

Abstract
- Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scalings. Homogeneous isotropic turbulence, correlations, Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence: Channel and boundary layer - Computation and modelling of turbulent flows

Objective
Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling

Content
- Properties of laminar, transitional and turbulent flows.
- Origin and control of turbulence. Instability and transition.
- Statistical description, averaging, equations for mean and fluctuating quantities, closure problem.
- Scalings, homogeneous isotropic turbulence, energy spectrum.
- Turbulent free shear flows. Jet, wake, mixing layer.
- Wall-bounded turbulent flows.
- Turbulent flow computation and modeling.

Lecture notes
Lecture notes are available

Literature

151-0951-00L Process Design and Safety W 4 credits 2V+1U P. Rudolf von Rohr

Abstract
Process design and safety deals with the fundamentals of process apparatus, plant design and safety.

Objective
The objective of the course is to introduce students to the design characteristics of systems for process engineering applications.

Content
Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry

Lecture notes
Script is available, English slides will be distributed

Literature

151-0927-00L Rate-Controlled Separations in Fine Chemistry W 4 credits 3G M. Mazzotti

Abstract
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Objective
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content
The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Lecture notes
Handouts during the class

Literature
Recommendations for text books will be covered in the class

Prerequisites /
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

252-0523-00L Computational Biology W 6 credits 3V+2U G. H. Gonnet

Abstract
Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis

Objective
Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

Content
This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

529-0611-00L Characterization of Catalysts and Surfaces W 7 credits 3G J. A. van Bokhoven, D. Ferri

Abstract
Basic aspects of surface science important for materials and catalysis research. Physical and chemical methods important for research in surface science, material science and catalysis are considered and their application is demonstrated on practical examples.

Objective
Basic aspects of surface science. Understanding of principles of most important experimental methods used in research concerned with surface science, material science and catalysis.

Content
Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.

529-0615-00L Polymerization Reaction and Colloid Engineering W 7 credits 3G M. Morbidelli

Abstract

Objective
Introduce the students to the design of polymerization reactors for the production of polymers with molecular characteristics suitably tuned for specific applications. This includes the post-treatment of polymer latexes and the analysis of their colloidal behavior.

Content
The aim of the course is to provide the tools needed for the understanding of the fundamental processes and the design of the industrial units involved in the production of polymeric materials and in the post-treatment of polymer colloids. In particular, the following topics are discussed: Physico-chemical characterization of polymers and description of the polymerization processes. Kinetics of free-radical polymerization and use of population balance models. Production of homo- and co-polymers with controlled characteristics in terms of molecular weight distribution and chain composition distribution. Living polymerizations. Design of polymerization reactors and the thermal runaway problem. Kinetics and control of emulsion polymerization. The radical segregation problem. Surfactants and colloidal stability. Aggregation kinetics and aggregate structure in conditions of diffusion and reaction limited aggregation. The role of shear conditions on aggregation and breakage kinetics and on the aggregate structure, Modeling and design of colloid aggregation processes.

Lecture notes
Skripts are available on the 'Polymerisation Reaction and Colloid Engineering' web page of the Morbidelli-group, vide the given link for details.

Literature

The 'Chemical Product Design' course teaches students quantitative concepts to analyze, select and transform theoretical concepts from chemistry and engineering into valuable real-world products. Basic chemistry and chemical engineering knowledge is required (Diffusion, Thermodynamics, Kinetics,...). This course starts with analyzing existing chemical needs and unmet technical challenges. We then develop the skills to critically analyze a specific chemical idea for a product, to rapidly test feasibility or chance for success and to eventually realize its manufacturing. The chemical engineering basics are then used to assess performance of products or devices with non-traditional functions based on dynamic properties (e.g. responsive building materials; personal medical diagnostics on paper strips). The course teaches the interface between chemistry and engineering into valuable real-world products. Basic chemistry and chemical engineering knowledge is required (Diffusion, Thermodynamics, Kinetics,...). They will be able to develop criteria to correctly use commercial software packages and critically evaluate their results.
Content

Part A: The 'Chemical Product Design' course starts with discussing questions along, 'What is a chemical product, and why do people pay for it? How does a given compound in a specific setting provide a service?' We then learn how to translate new, often ill-defined wishes or ideas into quantifiable specifications.

Part B: Thermodynamic and kinetic data allow sharp selection criteria for successful products. We learn how to deal with insufficient data and development of robust case models to evaluate their technical and financial constraints. How can parameters of a running process in one industry be scaled into another industry? Can dimensionless engineering numbers be applied beyond traditional chemical processes?

Part C: Manufacturing of commodity products, devices and molecular products: Chemical reactors, separation and detection or isolation units as part of a toolbox. Planning of manufacturing and decisions based on hard data. Providing quantitative answers on potential value generated.

Students are expected to actively develop chemical products along the course. Contributions will be made individually, or in small groups, where a larger topic is studied.

Literature


529-0643-00L Process Design and Development W 7 credits 3G G. Storti

Abstract

The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.

Objective

The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.

Content


Lecture notes

no script

Literature


Prerequisites / notice

Prerequisite: Thermal Unit Operations

529-0617-00L Catalysis Engineering W 7 credits 3G J. Pérez-Ramírez

Abstract

The purpose of the "Catalysis Engineering" course is to provide students with tools that enable the optimal design of catalytic materials and reactor engineering concepts favoring more sustainable manufacturing processes within the chemical industry.

Objective

The course aims at illustrating, from conception to implementation, the design of sustainable catalytic processes by integration of the microlevel (catalyst), mesolevel (reactor), and macrolevel (process). The word "sustainable" implies intensified processes with an improved exploitation of raw materials, wider use of renewable feedstocks, reduction of energy consumption, and minimized environmental impact. By the use of modern case studies of industrial relevance, aspects of catalyst preparation and characterization, kinetics, mass and heat transport, and deactivation are discussed. Emphasis is put on understanding the interaction among these basic elements in order to select the optimal catalytic process. Since no textbooks covering this area are available at this time and the intention of this course is unique, the lectures will be based on own texts and journal articles. During the course, there will be specific topics addressed by industrial contributors.

Content

The following general aspects:

- Catalyst preparation and characterization
- Kinetics
- Mass and heat transport
- Selectivity
- Deactivation

will be demonstrated for modern catalytic materials and processes of industrial relevance such as:

- Chlorine recycling
- N2O abatement
- Chemoselective hydrogenations
- Hierarchical zeolite catalysts
- Syngas conversion
- Biomass to chemicals and fuels

Lecture notes

The course material is based on own script, journal articles, and slides.

Prerequisites / notice

It is assumed that students selecting this course are familiar with general concepts of catalysis, reactor design, and transport phenomena.

529-0643-00L Biocatalysis Engineering W 7 credits 3G A. de Mello

Abstract

Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

Objective

In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.
Specific topics in the course include, but not limited to:

1. Theoretical Concepts
   Features of mass and thermal transport on the microscale
   Key scaling laws
2. Microfluidic Device Manufacture
   Conventional lithographic processing of rigid materials
   Soft lithographic processing of plastics and polymers
3. Mass fabrication of polymeric devices
4. Unit operations and functional components
   Analytical separations (electrophoresis and chromatography)
   Chemical and biological synthesis

Sample pre-treatment (filtration, SPE, pre-concentration)
Molecular detection
5. Design Workshop
   Design of microfluidic architectures for PCR, distillation & mixing
6. Contemporary Applications in Biophysical Analysis
   Microarrays
   Cellular analyses (single cells, enzymatic assays, cell sorting)

Projects on chemical assessment; time frame totals ca. 80 hours.

Projects on chemical assessment with the focus on the following aspects:

* Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
* Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
* Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
* Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
* Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Project teaching; time frame totals ca. 80 hours.

Projects on chemical assessment with the focus on the following aspects:

- Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
- Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
- Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
- Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
- Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Project teaching; time frame totals ca. 80 hours.

Lecture notes
See recommended literature.

Literature

Prerequisites / notice
Co-operation with chemical companies.
Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste, CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed during the course.

Literature

Prerequisites / notice
Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

376-1714-00L
Biomaterials

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. The interface between the materials and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts can be accessed online.

Literature
(available online via ETH library)

Handouts provided during the classes and references therin.

636-0007-00L
Computational Systems Biology

Abstract
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content
Biological systems have witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequence data, provides a prominent example. Recently, however, there has been a growing appreciation of the fact that biological functions are essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions, and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These will be based on (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), and (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Literature

636-0003-00L
Biological Engineering and Biotechnology

Abstract
Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective
1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines
3. Everything Under Control I. Regulated Transgene Expression in Mammalian Cells - Facts and Future
4. Secretion Engineering. The Traffic Jam getting out of the Cell
5. From Target To Market. An Antibody's Journey From Cell Culture to the Clinics
6. From Target To Market. An Antibody's Journey From Cell Culture to the Market
7. Functional Food. Enjoy your Meal!
8. Industrial Genomics. Getting a Systems View on Nutrition and Health - An Industrial Perspective
9. IP Management - Food Technology. Protecting Your Knowledge For Business
10. Biopharmaceutical Manufacturing I. Introduction to Process Development
11. Biopharmaceutical Manufacturing II. Up-stream Development
12. Biopharmaceutical Manufacturing III. Downstream Development
13. Biopharmaceutical Manufacturing IV. Pharma Development

Lecture notes
Handouts during the course.
### Other Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>227-0663-00L</td>
<td>Nano-Optics</td>
<td>W</td>
<td>6</td>
<td>2V+U</td>
<td>Novotny</td>
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<tr>
<td>529-0300-00L</td>
<td>Research Project</td>
<td>O</td>
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<td>8A</td>
<td>Professors</td>
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<tr>
<td>529-0637-00L</td>
<td>Chemical Engineering Laboratory II</td>
<td>O</td>
<td>8</td>
<td>8P</td>
<td>Morbidelli, Hungerbühler, K., Hungerbühler, N., Körber, F. C. I. Meemken</td>
</tr>
<tr>
<td>529-0459-00L</td>
<td>Case Studies in Process Design</td>
<td>O</td>
<td>7</td>
<td>3A</td>
<td>Hungerbühler, K., Capón García, E., Szilárt</td>
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</tbody>
</table>

### Laboratory Course, Research Project, and Case Study

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<tr>
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<td>6</td>
<td>2V+U</td>
<td>Novotny</td>
</tr>
<tr>
<td>529-0300-00L</td>
<td>Research Project</td>
<td>O</td>
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<td>8A</td>
<td>Professors</td>
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<td>O</td>
<td>8</td>
<td>8P</td>
<td>Morbidelli, Hungerbühler, K., Hungerbühler, N., Körber, F. C. I. Meemken</td>
</tr>
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<td>7</td>
<td>3A</td>
<td>Hungerbühler, K., Capón García, E., Szilárt</td>
</tr>
</tbody>
</table>

### Compulsory Electives in Humanities, Social and Political Sciences

- Recommended GESS compulsory elective courses (Type B) for D-CHAB.
- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses ETH/UVZH

### Master Thesis

<table>
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<tr>
<th>Number</th>
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<th>Type</th>
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<td>O</td>
<td>20</td>
<td>43D</td>
<td>Professors</td>
</tr>
</tbody>
</table>
Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Duration of the Master's Thesis 16 weeks.

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is carried out in a research group of the Department of Chemistry and Applied Biosciences, usually in the Institute of Chemical and Bioengineering, as chosen by the student.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Objective
The objective of the lecture course Biology II is the understanding of form, function, and development of animals and of the basic underlying mechanisms.

Content
The following numbers of chapters refer to the text-book "Biology" (Campbell & Reece, 7th edition, 2005) on which the course is based.

1. Genomes, DNA Technology, Genetic Basis of Development
Chapter 19: Eukaryotic Genomes: Organization, Regulation, and Evolution
Chapter 20: DNA Technology and Genomics
Chapter 21: The Genetic Basis of Development

2. Form, Function, and Development of Animals I
Chapter 40: Basic Principles of Animal Form and Function
Chapter 41: Animal Nutrition
Chapter 44: Osmoregulation and Excretion
Chapter 47: Animal Development

3. Form, Function, and Development of Animals II
Chapter 42: Circulation and Gas Exchange
Chapter 43: The Immune System
Chapter 45: Hormones and the Endocrine System
Chapter 48: Nervous Systems
Chapter 49: Sensory and Motor Mechanisms

Literature
The following text-book is the basis for the courses Biology I and II:

Prerequisite: Lecture course Biology I of winter semester

529-0051-AAL Analytical Chemistry I  E-  3 credits  6R  D. Günther, R. Zenobi

Abstract
Introduction into the most important spectroscopical methods and their applications to gain structural information.

Objective
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Content
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:

- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
- UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) and optical rotation dispersion (ORD).


Lecture notes
Script will be for the production price

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995
- E. Pretsch, P. Bühlmann, C. Aflötter, M. Badertscher, Spektroskopische Daten zur Strukturaufklärung organischer Verbindungen, 4. Auflage, Springer, Berlin/Heidelberg, 2001-

Prerequisites / notice
Excercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

551-0013-AAL Biochemistry  E-  2 credits  4R  R. Glockshuber

Abstract
The lecture is a basic introductory course on the molecular principles of biology for students who need to pass this course for admission to their MSc curriculum.

Objective
The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.

Content
The course content is based on the following chapters of the textbook Biochemistry (Berg, Tymoczko, Stryer, 7th edition, 2012, Freeman & Co, New York)

- Chapter 1: The molecular design of life
- Chapter 2: Protein composition and structure
- Chapter 3: Exploring proteins and proteomes
- Chapter 4: DNA, RNA and the flow of information
- Chapter 5: Exploring Genes and Genomes
- Chapter 7: Hemoglobin
- Chapter 8: Enzymes and the basic concepts of catalysis
- Chapter 11: Carbohydrates
- Chapter 12: Lipids and cell membranes
- Chapter 15: Metabolism: Basic concepts and design

Literature

Chemical and Bioengineering Master - Key for Type

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

Key for Hours

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

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Unterlagen werden als PDF über die ILIAS-Plattform zur Verfügung gestellt.

Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic Mathematical Foundations I: Analysis A

Biology I

R. Glockshuber

Introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, O

ELECTS

2V+1U

Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium O

Understanding and describing ionic equilibria from both a qualitative and a quantitative perspective

Lecturers


Chemical Engineering Bachelor

1. Semester

Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0011-02L</td>
<td>General Chemistry (Inorganic Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>A. Togni</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the chemistry of ionic equilibria: Acids and bases, redox reactions, formation of coordination complexes and precipitation reactions</td>
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<tr>
<td>Objective</td>
<td>Understanding and describing ionic equilibria from both a qualitative and a quantitative perspective</td>
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</tr>
<tr>
<td>Content</td>
<td>Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium concentrations, acidity functions, Lewis acids, acids in non-aqueous solvents, redox reactions and equilibria, Galvanic cells, electrode potentials, Nernst equation, coordination chemistry, stepwise formation of metal complexes, solubility</td>
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<tr>
<td>Lecture notes</td>
<td>Literature</td>
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<tr>
<td></td>
<td>Copies of the course slides as well as other documents will be provided as pdf files via the ILIAS platform (myStudies)</td>
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</tr>
<tr>
<td>529-0011-03L</td>
<td>General Chemistry (Organic Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>H. Wennemers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions.</td>
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<tr>
<td>Objective</td>
<td>Introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry.</td>
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<tr>
<td>Content</td>
<td>Introduction to the history of organic chemistry, introduction to nomenclature, learning of classical structures and stereochemistry: isomerism, Fischer projections, CIP rules, point groups, molecular symmetry and chirality, topicity, chemical bonding: Lewis bonding model and resonance theory in organic chemistry, description of linear and cyclic conjugated molecules, aromaticity, Huckel rules, organic thermochemistry, learning of organic chemistry reactions, intermolecular interactions.</td>
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<tr>
<td>Lecture notes</td>
<td>Literature</td>
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<td></td>
<td>Unterlagen werden als PDF über die ILIAS-Plattform zur Verfügung gestellt</td>
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<tr>
<td>529-0011-01L</td>
<td>General Chemistry (Physical Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>F. Merkt</td>
</tr>
<tr>
<td>Abstract</td>
<td>Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.</td>
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<tr>
<td>Objective</td>
<td>Introduction to Physical Chemistry</td>
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<tr>
<td>Content</td>
<td>Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases</td>
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<tr>
<td>Lecture notes</td>
<td>Literature</td>
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<tr>
<td></td>
<td>See homepage of the lecture.</td>
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<tr>
<td></td>
<td>Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung.</td>
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<tr>
<td>551-0015-00L</td>
<td>Biology I</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>R. Glockshuber, E. Hafen</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.</td>
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<tr>
<td>Content</td>
<td>Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch &quot;Biology&quot; (Campbell &amp; Rees, 7th edition, 2005) Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt</td>
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<tr>
<td></td>
<td>1. Aufbau der Zelle</td>
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<tr>
<td></td>
<td>Kapitel 5: Struktur und Funktion biologischer Makromoleküle</td>
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<td></td>
<td>Kapitel 6: Eine Tour durch die Zelle</td>
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<td></td>
<td>Kapitel 7: Membranstruktur und-funktion</td>
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<td></td>
<td>Kapitel 8: Einführung in den Stoffwechsel</td>
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<td></td>
<td>Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie</td>
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<td></td>
<td>Kapitel 10: Photosynthese</td>
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<td>Kapitel 12: Der Zelltzyklus</td>
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<td>Kapitel 17: Vom Gen zum Protein</td>
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<td></td>
<td>2. Allgemeine Genetik</td>
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<td></td>
<td>Kapitel 13: Meiose und Reproduktionszyklen</td>
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<td></td>
<td>Kapitel 14: Mendel'sche Genetik</td>
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<td></td>
<td>Kapitel 15: Die chromosomale Basis der Vererbung</td>
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<td></td>
<td>Kapitel 16: Die molekulare Grundlage der Vererbung</td>
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<td></td>
<td>Kapitel 18: Genetik von Bakterien und Viren</td>
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<td></td>
<td>Kapitel 46: Tierische Reproduktion</td>
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<tr>
<td></td>
<td>Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik</td>
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<tr>
<td></td>
<td>Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.</td>
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<tr>
<td></td>
<td>Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:</td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
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<tr>
<td>401-0271-00L</td>
<td>Mathematical Foundations I: Analysis A</td>
<td>O</td>
<td>5 credits</td>
<td>3V+2U</td>
<td>T. Bühler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to calculus in one dimension. Building simple models and analysing them mathematically. Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Introduction to calculus in one dimension. Building simple models and analysing them mathematically.</td>
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</tr>
</tbody>
</table>
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

For more information: www.csms.ethz.ch/education/lnfol

Objective
Discuss fundamentals of computer architecture, languages, algorithms and programming with an eye to their application in the area of chemistry, biology and material science.

Content
Minimal introduction to UNIX, Data representation and processing, algorithms and programming in C++, Errors, programming guidelines, efficiency, computer architecture, algorithms for sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, software engineering.

Lecture notes
Available in (English), distributed at first lecture

Literature
See: www.csms.ethz.ch/education/lnfol

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the written exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/lnfol

### Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0011-04L</td>
<td>Practical Course General Chemistry</td>
<td>O</td>
<td>8 credits</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
</tbody>
</table>

Latest online enrolment is one week before the beginning of the semester.

Information about the practical course will be given on the first day.

Abstract
Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements, metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration)

Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes
http://www.gruetzmacher.ethz.ch/education/laborcourses

Prerequisites / notice
Compulsory: online enrolment latest one week prior to the start of the semester

### 3. Semester

#### Compulsory Subjects Examination Block I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0121-00L</td>
<td>Inorganic Chemistry I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>A. Mezzetti</td>
</tr>
</tbody>
</table>

Complexes of the transition metals: structure, bonding, spectroscopic properties, and synthesis.

General synthetic strategies.

Content
The chemical bond (overview). Symmetry and group theory. The chemical bond of coordination compounds (Valence Bond Theory, Crystal Field Theory, Molecular Orbital Theory (sigma- and pi-bonding), pi-Acceptors ligands (CO, NO, olefins, dioxygen, rhodium, phosphines and phosphites). Electronic spectra of coordination compounds (Tanabe-Sugano diagrams). Coordination numbers and isomers in complexes. Dynamic phenomena (stereochemical nonrigidity). Complexes and kinetics.

Lecture notes
Can be bought at the HCI-shop

Literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0221-00L</td>
<td>Organic Chemistry I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>F. Diederich, C. Schaack</td>
</tr>
</tbody>
</table>

Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Objective
Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

Content
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Lecture notes
A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.

Literature
No set textbooks. Optional literature will be proposed at the beginning of the class and in the lecture notes.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0422-00L</td>
<td>Physical Chemistry II: Introduction to Chemical Reaction Kinetics</td>
<td>O</td>
<td>4 credits</td>
<td>3V+1U</td>
<td>H. J. Wörner</td>
</tr>
</tbody>
</table>


Objective
Introduction to Chemical Reaction Kinetics

Content

Lecture notes

Literature

Prerequisites / notice
- Voraussetzungen:
  - Mathematik I und II
  - Allgemeine Chemie I und II
  - Physikalische Chemie I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecture Lecturer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0043-00L</td>
<td>Physics I</td>
<td>4</td>
<td>M. R. Meyer</td>
</tr>
<tr>
<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>3</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
<tr>
<td>401-0373-00L</td>
<td>Mathematics III: Partial Differential Equations</td>
<td>4</td>
<td>F. Da Lio</td>
</tr>
</tbody>
</table>

Abstract
Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Content
Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)

Lecture notes
The lecture follows the book "Physics" by Paul A. Tipler.

Literature

Prerequisites / notice
Prerequisites: Mathematics I & II

Abstract
Introduction into the most important spectroscopical methods and their applications to gain structural information.

Content
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Application oriented basics of organic and inorganic instrumental analysis and of the theoretical employment of structure elucidation methods:
- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- IR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- Raman spectroscopy.
- NMR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra;

Lecture notes
Script will be for the production price

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice
Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic comounds" (4th semester) is recommended.

Abstract

Objective
The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.
Content

## Examples of partial differential equations
- Classification of PDEs
- Superposition principle

## One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

## Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

## Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

## Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

Lecture notes
There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

Literature
2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press
3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)

Prerequisites / notice
Prerequisites:
- Practical Course General Chemistry (1. Semester, 529-0011-04)
- Practical Course Inorg. and Org. Chemistry I (2. Sem., 529-0230)
- Attendance of Course Inorg. Chemistry 1 (3. Sem., 529-0121)
If necessary, access priority will be settled according to the results of the first-year examinations.

### 5. Semester

#### Compulsory Subjects

#### Examination Block Thermodynamics and Transport Phenomena

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0557-00L</td>
<td>Chemical Engineering Thermodynamics</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>A. Butté</td>
</tr>
</tbody>
</table>

Abstract
This course teaches the fundamentals of thermodynamics applied to the description of real mixtures in the presence of physicochemical equilibria, including methods to quantitatively estimate them. While giving insights into the meaning and properties of main thermodynamic quantities, the course keeps primary focus on application to real chemical engineering problems.

Objective
The objective of the course is twofold. First, to teach the methods to calculate the volumetric and thermodynamic properties of mixtures in the presence of physicochemical equilibria. In particular, students are supposed to acquire the knowledge on which thermodynamic properties have to be estimated to carry out such calculation, on which data which need to be gathered and estimated, on the methods, the relative assumption and approximations. Second, the course is intended to give the students a sufficient theoretical insight on the thermodynamic properties, which will be used for future applications and studies.
The first part of the course is focusing on pure fluids (ideal and real). First, some fundamentals of thermodynamics are reviewed, including thermodynamic quantities and balances (of mass, energy and entropy). Then, equations of state and their use to estimate the volumetric properties of pure fluids are introduced. Finally, it is discussed how to use previous results for the estimation of the main thermodynamic properties (internal energy, enthalpy, entropy, free Gibbs energy, fugacity, etc.).

The second part of the course is focusing on mixtures, starting from binary mixture to mixtures of N components. Again, real mixtures are discussed, with emphasis on when such mixtures can be approximated as ideal ones and on the corrections which are needed to switch from ideal to real mixtures. As for pure fluids, first the use of the equations of state is discussed to estimate volumetric properties, then the estimation of thermodynamic properties of mixtures is introduced. In this part, a particular focus is given to phase equilibria in the absence of chemical reactions. The most common equilibria (liquid-vapor, solid-liquid, liquid-liquid, etc.) are discussed.

In the last part of the course, the chemical equilibria are discussed, with particular focus on the calculation of mass and energy balances for multicomponent systems (mixtures), also in the presence of physical equilibria.

During the lectures, theoretical aspects will be discussed and will be linked to application by the discussion of a comprehensive study case, including the methods for its solution. Detailed exercises will be given (and discussed later) to the students, to let them familiarize with the main techniques discussed during the lectures.

No script will be available. Support material consists of PowerPoint presentations, which will be available in PDF format online.


Acquisition of material properties and data:

5. "TRC Thermodynamic Tables", Thermodynamic Research Center, College Station USA

Three tests are offered for practicing the course material. Participation is voluntary.

This course teaches the basis and the methods for the description and for the quantitative treatment of heat transfer and fluid flow with emphasis on physico-chemical processes.

At the end of this course students should be familiar with the basics of heat transfer and fluid dynamics, and have acquired the ability to describe these phenomena in practical processes and to perform corresponding calculations.

Mechanisms of heat and momentum transfer; analogy between mass, heat and momentum transfer; dimensional analysis; kinematics and continuum mechanics; steady and non-steady heat conduction; convective heat transfer; heat transfer correlations; radiation heat transfer; steady and non-steady; laminar and turbulent flow; inviscid flows; Navier-Stokes equations; Bernoulli equation; boundary layer theory; multiphase flow

Lecture notes: Lecture notes will be handed out.

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

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Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.


Three tests are offered for practicing the course material. Participation is voluntary.

This course teaches the basis and the methods for the description and for the quantitative treatment of heat transfer and fluid flow with emphasis on physico-chemical processes.

At the end of this course students should be familiar with the basics of heat transfer and fluid dynamics, and have acquired the ability to describe these phenomena in practical processes and to perform corresponding calculations.

Mechanisms of heat and momentum transfer; analogy between mass, heat and momentum transfer; dimensional analysis; kinematics and continuum mechanics; steady and non-steady heat conduction; convective heat transfer; heat transfer correlations; radiation heat transfer; steady and non-steady; laminar and turbulent flow; inviscid flows; Navier-Stokes equations; Bernoulli equation; boundary layer theory; multiphase flow

Lecture notes: Lecture notes will be handed out.
This course covers common numerical algorithms and statistical methods used by chemical engineers to solve typical problems arising in chemical reactors. Residence time distribution. Analysis and design of real reactors. Fast reactions in turbulent flows. Sensitivity and stability of chemical reactors.

Provide to the students a complete methodology for the analysis and design of homogeneous reactors


Parametric sensitivity and stability in chemical reactors.

Scripts are available online on the web page of the Morbidelli group.

Statistical and Numerical Methods for Chemical Engineers

Teaching of basic knowledge in microbiology.

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

Wird von den jeweiligen Dozenten ausgegeben.

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

This course covers common numerical algorithms and statistical methods used by chemical engineers to solve typical problems arising in industrial and research practice.

The focus is on application of these algorithms to real-world problems, while the underlying mathematical principles are also explained. The MATLAB environment is adopted to integrate computation, visualization and programming.

Part I: Numerical Methods:
- Systems of linear equations: direct and iterative methods
- Systems of non-linear equations
- Eigenvalue problems and the singular value decomposition
- Linear and non-linear least squares
- Quadrature: deterministic and Monte-Carlo methods
- Ordinary differential equations (non stiff and stiff): initial value problems and structure preservation

Part II: Statistical Methods:
- Data analysis and regression methods
- Statistical experimental design
- Multivariate analysis of spectra

Lecture slides will be provided for the part on the numerical methods.

Discovering Management offers an integrated learning system, which combines in an innovative format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'.

While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Discovering Management offers an integrated learning system, which combines in an innovative format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

752-4001-00L Microbiology 0 2 credits 2V M. Ackermann, M. Schuppler, J. Vorholt-Zambelli

Abstract

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

Objective

Topics covered:
- Systems of linear equations: direct and iterative methods
- Systems of non-linear equations
- Eigenvalue problems and the singular value decomposition
- Linear and non-linear least squares
- Quadrature: deterministic and Monte-Carlo methods
- Ordinary differential equations (non stiff and stiff): initial value problems and structure preservation

Content


Literature

Wird von den jeweiligen Dozenten ausgegeben.

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

401-0675-00L Statistical and Numerical Methods for Chemical Engineers 0 3 credits 2V+2U R. Käppeli, P. Müller, M. Sokolov

Abstract

This course covers common numerical algorithms and statistical methods used by chemical engineers to solve typical problems arising in industrial and research practice.

Objective

Part I: Numerical Methods:
- Systems of linear equations: direct and iterative methods
- Systems of non-linear equations
- Eigenvalue problems and the singular value decomposition
- Linear and non-linear least squares
- Quadrature: deterministic and Monte-Carlo methods
- Ordinary differential equations (non stiff and stiff): initial value problems and structure preservation

Content

Lecture slides will be provided for the part on the numerical methods.

For the statistics part, see http://stat.ethz.ch/~meier/teaching/cheming/

Literature

Recommended reading:
2) A. Constantinides, N. Mostoufi, Numerical Methods for Chemical Engineers with Matlab Applications, Prentice Hall, 1999
4) W. A. Stahl, Statistische Datenanalyse, Vieweg, 4th edition 2002

351-0778-00L Discovering Management Entry level course in management for BSc, MSc and PhD students at all levels not belonging to D-MTEC. This course can be complemented with Discovering Management (Exercises) 351-0778-01.

Abstract

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective

Discovering Management offers an integrated learning system, which combines in an innovative format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

P. Baschera


J. Baldyga and J. R. Bourne, Turbulent Mixing and Chemical Reactions, John Wiley, 1999


A. Varma and M. Morbidelli, Mathematical Methods in Chemical Engineering, Oxford University Press, 1997

1) R. Pratap, Getting Started with Matlab: A Quick Introduction for Scientists and Engineers, Qxford University Press, 2001
2) A. Constantinides, N. Mostoufi, Numerical Methods for Chemical Engineers with Matlab Applications, Prentice Hall, 1999
4) W. A. Stahl, Statistische Datenanalyse, Vieweg, 4th edition 2002

2) A. Constantinides, N. Mostoufi, Numerical Methods for Chemical Engineers with Matlab Applications, Prentice Hall, 1999
4) W. A. Stahl, Statistische Datenanalyse, Vieweg, 4th edition 2002
The lectures for Discovering Management are designed to broaden the participant's understanding of the principles of entrepreneurial management, emphasizing the interdependence of various specialties in the development and management of a firm. For this reason, the lectures are structured on the basis of a coherent business model and will be presented by the respective area specialists at D-MTEC. The lectures broaden the view and the understanding of technology by interlinking it with society. Corporate sustainability, for example, introduces economic, ecological and social issues that are relevant to all engineering disciplines. Practical examples stimulate the students to assess these issues and be aware of their responsibilities as engineers. Technology and innovation management, to mention a second example, focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students' ability to see the business and social consequences of their 'technical' decisions. Critical skills will be trained by the case study exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant's appreciation for the complex tasks companies deal with.

Discovering Management attempts to overcome the limitations of traditional teaching curricula of management in technical universities, which often merely focus on transferring specific skills to students, e.g. planning or forecasting. In response to the new challenges for entrepreneurial decision-making, students will be offered the opportunity to actively engage in an advanced business game simulation; a business game that establishes a link between business management theory and business management in practice. The simulation presents a realistic model of a company and provides participants with the opportunity to quickly gain the lasting effects of practical experience in a risk-free environment. All this provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyze the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

No prior knowledge of business or economics is required to successfully complete this course.

Examination Block Catalysis and Heterogeneous Process Engineering
Subjects will be given in spring semester

Examination Block Process Engineering
Subjects will be given in spring semester

Laboratory Courses and Case Studies

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>529-0639-01L</td>
<td>Chemical Engineering Laboratory I</td>
<td>O</td>
<td>6</td>
<td>8P</td>
<td>M. Morbidelli, N. Kober</td>
</tr>
</tbody>
</table>

Compulsory Electives in Humanities, Social and Political Sciences

- Recommended GESS compulsory elective courses (Type B) for D-CHAB
- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses ETH/UZH

Chemical Engineering Bachelor - Key for Type

<p>| E- | Recommended, not eligible for credits | O   | Compulsory |
| Z | Courses outside the curriculum       | W+  | Eligible for credits and recommended |
| Dr| Suitable for doctorate               | W   | Eligible for credits |</p>
<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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ECTS: European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Core Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>857-0007-00L</td>
<td>Methods I: Research Design, Qualitative Methods, and Data Collection</td>
<td>O</td>
<td>8</td>
<td>2U+2S</td>
<td>C. Bara, F. Schimmelfennig, S. Bailer, T. Ohmura</td>
</tr>
<tr>
<td>857-0007-00L</td>
<td>Democracy</td>
<td>O</td>
<td>8</td>
<td>2S</td>
<td>F. Schimmelfennig, D. Kübler</td>
</tr>
<tr>
<td>857-0007-00L</td>
<td>Political Violence</td>
<td>O</td>
<td>8</td>
<td>2S</td>
<td>L.E. Cederman, A. Wenger</td>
</tr>
<tr>
<td>857-0091-00L</td>
<td>Methods II: Quantitative Methods</td>
<td>O</td>
<td>4</td>
<td>3S</td>
<td>J. Bölstad, L. Beiser-McGrath</td>
</tr>
</tbody>
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## Electives

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>857-0003-00L</td>
<td>Contemporary Security Studies</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>M. Dunn Cavelty, J. Hagmann</td>
</tr>
<tr>
<td>857-0094-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>T. Bernauer</td>
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</table>

### Comparative and International Studies Master

#### Core Seminars

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<th>Number</th>
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<tr>
<td>857-0007-00L</td>
<td>Methods I: Research Design, Qualitative Methods, and Data Collection</td>
<td>O</td>
<td>8</td>
<td>2U+2S</td>
<td>C. Bara, F. Schimmelfennig, S. Bailer, T. Ohmura</td>
</tr>
<tr>
<td>857-0007-00L</td>
<td>Democracy</td>
<td>O</td>
<td>8</td>
<td>2S</td>
<td>F. Schimmelfennig, D. Kübler</td>
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<tr>
<td>857-0007-00L</td>
<td>Political Violence</td>
<td>O</td>
<td>8</td>
<td>2S</td>
<td>L.E. Cederman, A. Wenger</td>
</tr>
<tr>
<td>857-0091-00L</td>
<td>Methods II: Quantitative Methods</td>
<td>O</td>
<td>4</td>
<td>3S</td>
<td>J. Bölstad, L. Beiser-McGrath</td>
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### Electives

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<td>4</td>
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<tr>
<td>857-0094-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>T. Bernauer</td>
</tr>
</tbody>
</table>

Development and Current Issues of European Integration, J. Bölstad, A. Zhelyazkova

Since its start in the fifties, the European Union has evolved into an ever more important multilevel system of integration in terms of the functioning of the EU institutions and the policy-making process (i.e. agenda-setting, decision-making and implementation). In the second part of the course, we analyze the problems confronting Europe during the process of European integration, as well as current issues associated with the EU's expansion of powers and membership. For example, key questions include: Is there a "democratic deficit" in the EU in terms of responsiveness to public opinion? To what extent does the existing EU institutional structure allow for representation? How can we explain patterns of "differentiated integration" across policy areas and countries? What are the consequences from the EU's enlargement on the "new" Central and Eastern European member states and the prospects for future entrants? We will conclude with a discussion about the Euro-crisis.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

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

The winds of change that swept over the Middle East and North Africa have transformed the political landscape in an unexpected manner. This seminar will look closely at the concept of political Islam and at the ideologies and programs of some of these parties and groups. It will also investigate the consequences of their participation on citizenship rights and the democratization process.
Objective
1. Examine the concept of political Islam and at the ideologies and programs of some of these parties and groups.
2. Examine some of these movements within the contexts of different countries
3. Investigate the consequences of their participation on citizenship rights and the democratization process.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Period</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0092-00L</td>
<td>Decentralisation, Local Democracy, and Social Justice W - European and Global Perspectives (UZH)</td>
<td>6</td>
<td>2S</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Abstract
In the first global report on decentralization published by the UCLG and the World Bank (2009) authors insist "While many of the problems facing cities and towns may be global, the solutions will, in large measure, be local and unique to the specific circumstances on the ground". The goal of this seminar is to understand and scrutinize the real-world relevance of this commonplace statement.

Objective
Part I: Decentralisation and local democracy
- Understanding central concepts: decentralisation, federalism, local autonomy, metropolitan governance, government/party systems, local democracy
- Gaining expert knowledge on selected cases
- Reflection and examination of possible relationships between decentralisation, local democracy, and social justice

Part II: Causes
- Account for the broader context: traditions, capacities, ethnic tensions

Part III: Consequences
- Fine tuning the model of decentralised democracy: values, trade-offs, conditions, aims

Presentation essay: Conceptual elaboration, theoretical argument case description, recommendations

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Period</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0093-00L</td>
<td>Visualizing and Analyzing Spatial Data in Political Science</td>
<td>4</td>
<td>2S</td>
<td>P. Hunziker</td>
</tr>
</tbody>
</table>

Abstract
This course introduces students to the analysis of geospatial data for applications in political science. It provides them with the tools and methods necessary for incorporating geospatial data in their own research projects, and guides participants through the entire workflow of creating, viewing, managing, visualizing, and analyzing geospatial data for understanding political phenomena.

Objective
The analysis of geospatial data is increasingly important in political science. Many traditional types of data that are used to understand political phenomena (e.g., survey data, voting data, governance indicators, etc.) refer to geospatial units (e.g., countries, cantons, villages, etc.). In addition, recent advances in computing allow for collecting and analyzing novel forms of geocoded information that are of tremendous value for modern social science applications, such as conflict event data, satellite imagery, or geo-tagged social media data. Managing, analyzing and visualizing these types of data require tools that go beyond the traditional skill set taught in basic social science methods classes.

This course introduces students to the tools and methods necessary for incorporating geospatial data in their own research projects, and guides participants through the entire workflow of creating, viewing, managing, visualizing, and analyzing geospatial data.

Overall, students will learn to
- view and manage geospatial data in various formats;
- develop a basic understanding of the problem of cartographic projection;
- collect, create, manipulate, and combine geospatial data for their own research projects;
- visualize geospatial data in maps and interactive applications;
- understand the challenges associated with analyzing geospatial data with statistical tools;
- prepare, run, and interpret basic spatial econometric models (linear SEM and SAR models).

Requirements:
- Basic understanding of linear regression and simple statistical concepts.
- Interest in quantitative analysis.
- Laptop (Win/Mac/Linux) for exercises.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Period</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0094-00L</td>
<td>Globalization: An Empirical Political Economy Perspective (University of Zurich)</td>
<td>6</td>
<td>2S</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Abstract
This course gives a broad overview of the various dimensions of globalization. It starts with discussing the measurement of globalization and then turns to its causes and consequences.

Objective
- Students are provided with a broad overview of the various dimensions of globalization
- They are aware of the options to measuring globalization and know about its causes and consequences.
- Students expand their view of globalization in an interdisciplinary framework
- Students learn and become able to express their views on the current research via intensive discussions
- Awareness of the current literature and its shortcomings (potential for further research)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Period</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>860-0001-00L</td>
<td>Public Institutions and Policy-Making Processes</td>
<td>6</td>
<td>3G</td>
<td>T. Bernauer, S. Bechtold, F. Schimmelfennig</td>
</tr>
</tbody>
</table>

Abstract
Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels.

Objective
Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g., interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.

Content
Schedule:
W1: (no class because of ISTP cornerstone course)
W2: Bechtold, Bernauer: Introduction
W3: Bechtold: Why do we need laws and why do people and other actors (e.g., firms) usually obey the law?
W4: Bechtold: How is the law enforced, and when do laws fail to influence the behavior of individuals and other actors (e.g., firms)?
W5: Bechtold: Courts as policy-makers
W6: Bernauer: How are parliaments (legislatures) elected, how do they work, and how do their characteristics and processes affect policy-making?
W7: Bernauer: Why do forms of government differ and how does this affect policy-making? Why and in what respect are public administrations efficient/effective, and why sometimes not?
W8: Bernauer: How do interest groups and social movements affect policy-making?
W9: Schimmelfennig: Governance beyond the state: why and how states create international institutions.
W10: Schimmelfennig: International organizations and regimes: case studies of global governance.
W11: Schimmelfennig: Governance in the European Union: policy-making and policy enforcement.
W12: Schimmelfennig: The international diffusion of policies: how states learn from each other.
W13: study week, Q&A meeting
W14: End of semester test
End of January: deadline for review essay

Lecture notes
Reading materials will be distributed to the students before the semester starts.

Prerequisites / notice
This is a Master level course. The course is capped at 25 students, with ISTP Master students having priority.

Master Thesis
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0019-00L</td>
<td>Master's Thesis Colloquium</td>
<td>O</td>
<td>4 credits</td>
<td>3K</td>
<td>D. Hangartner</td>
</tr>
</tbody>
</table>

Permission to begin master thesis is required to take part in Colloquium.

Abstract
In this colloquium, students enrolled in the MACIS program first present and discuss research design and methods issues concerning their prospective MA theses. Towards the end of the semester they present preliminary findings from their MA thesis work.

Objective
It is the goal of the colloquium to help students with the initial steps of writing their master theses. During the colloquium, they will develop a relevant research question and hypotheses and select appropriate methods and data.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0021-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>26 credits</td>
<td>56D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
The Master Thesis is an independent piece of research on an issue in comparative and international politics. It combines theory, methods, and empirical work.

Objective
The Thesis should demonstrate the students’ ability to conduct independent research on the basis of the theoretical and methodological knowledge acquired during the MA program.

Comparative and International Studies Master - Key for Type
<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E- Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr Suitable for doctorate</td>
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</table>

Key for Hours
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<tr>
<th>Key</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P practical/laboratory course</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0523-00L</td>
<td>Computational Biology</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>G. H. Gonnet</td>
</tr>
<tr>
<td></td>
<td>Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.</td>
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<td></td>
<td>Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.</td>
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<td>This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.</td>
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<tr>
<td>262-5120-00L</td>
<td>Principles of Evolution: Theory (University of Zurich)</td>
<td>W</td>
<td>6</td>
<td>3V</td>
<td>University lecturers</td>
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<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO351</td>
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<td></td>
<td>&quot;Nothing in Biology Makes Sense Except in the Light of Evolution&quot;. Evolutionary theory and methods are essential in all branches of modern biology.</td>
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<td></td>
<td>Subject specific skills:</td>
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<td>By the end of the course, students will be able to:</td>
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<tr>
<td></td>
<td>o describe basic evolutionary theory and its applications</td>
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<td></td>
<td>o discuss ongoing debates in evolutionary biology</td>
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<td>o critically assess the presentation of evolutionary research in the popular media</td>
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<td>Key skills:</td>
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<td>By the end of the course, students will be able to:</td>
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<td></td>
<td>o approach biological questions from an evolutionary perspective</td>
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<td>This course will provide a broad overview of current evolutionary thought, including the mechanisms of evolutionary change, adaptation and the history of life and will involve practical field and lab work as well as lecture material.</td>
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<tr>
<td>263-5150-00L</td>
<td>Scientific Databases</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>G. H. Gonnet</td>
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<tr>
<td></td>
<td>Scientific databases share many aspects with classical DBs, but have additional specific aspects. We will review Relational DBs, Object Oriented DBs, Knowledge DBs, textual DBs and the Semantic Web. All these topics will be studied from the point of view of the scientific applications (Bioinformatics, Physics, Chemistry, Health, Engineering) A toy SDB will be used for exercises.</td>
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<td>The goals of this course are to:</td>
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<td></td>
<td>(a) Familiarize the students with how existing DBs can be used for scientific applications.</td>
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<td>(b) Recognize the areas where SciDBs differ and require additional features compared to classical DBs.</td>
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<td>(c) Be able to understand more easily SciDBs, improve existing ones or design/create new ones.</td>
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<td>(d) Familiarize the students with at least two examples of SciDBs.</td>
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</table>
Content
1) Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area.
   - Hierarchy: File systems, data bases, knowledge bases and variations.
   - Efficiency issues and how they differ from classical DB.
2) - Relational DB used for scientific data, pros/cons
   - Introduction to RDB, limitations of the model, basics of SQL,
   - handling of metadata, examples of scientific use of RDBs.
3) - Object Oriented DB. Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching,
   - Space and access time efficiency of OODBs.
4) - Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.
5) - MapReduce / Hadoop
6) - Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.
7) - SGML and XML, human-readable databases, genomic databases.
   - Advantages of human-readable databases (the huge initial success of genomic databases).
8) - Semantic web, Resource Description Framework (RDF) triples, SparQL.
   - An example of very flexible database for knowledge storage. Goals of the Semantic Web, discussion about its future.
9) - An ideal scenario (and the design of a toy system with most of the desired features for exploration and exercises).
11) - Functional testing, Verifiers, Consistency, Short-circuit testing.
   - Recovery and Automatic recovery, Backup (incremental) methods.
12) - Performance and space issues, various uses of compression, concurrency control.
   - Hardware issues, clusters, Cloud computing, Crowd-sourcing.
13) - Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

Literature
Several papers and online articles will be made available.
There is no single textbook for this course. A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

401-6282-00L Statistical Analysis of High-Throughput Genomic and Translcriptomic Data (University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: STA426
Abstract
A range of topics will be covered, including basic molecular biology, genomics technologies and in particular, a wide range of statistical and computational methods that have been used in the analysis of DNA microarray and high throughput sequencing experiments.
Objective
- Understand the fundamental "scientific process" in the field of Statistical Bioinformatics
- Be equipped with the skills/tools to preprocess genomic data (Unix, Bioconductor, mapping, etc.) and ensure reproducible research (Sweave)
- Have a general knowledge of the types of data and biological applications encountered with microarray and sequencing data
- Have the general knowledge of the range of statistical methods that get used with microarray and sequencing data
- Gain the ability to apply statistical methods/knowledge/software to a collaborative biological project
- Gain the ability to critical assess the statistical bioinformatics literature
- Write a coherent summary of a bioinformatics problem and its solution in statistical terms
Content
Lectures will include: microarray preprocessing; normalization; exploratory data analysis techniques such as clustering, PCA and multidimensional scaling; Controlling error rates of statistical tests (FPR versus FDR versus FWER); limma (linear models for microarray analysis); mapping algorithms (for RNA/ChIP-seq); RNA-seq quantification; statistical analyses for differential count data; isoform switching; epigenomics data including DNA methylation; gene set analyses; classification
Lecture notes
Lecture notes, published manuscripts
Prerequisites / notice
Prerequisites: Basic knowledge of the programming language R, sufficient knowledge in statistics

551-0307-00L Biomolecular Structure and Mechanism I: Protein Structure and Function
D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course
Abstract
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.
Objective
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.
Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.
### 636-0007-00L Computational Systems Biology

**W**  6 credits  3V+2U  J. Stelling

**Abstract**
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

**Objective**
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

**Content**
Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

**Literature**


### 636-0009-00L Evolutionary Dynamics

**W**  5 credits  2V+1U  N. Beerwinkel

**Abstract**
Evolutionary dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.

**Objective**
The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.

**Content**
Evolution is the one theory that encompasses all of biology. It provides a single, unifying concept to understand the living systems that we observe today. We will introduce several types of mathematical models of evolution to describe gene frequency changes over time in the context of different biological systems, focusing on asexual populations. Viruses and cancer cells provide the most prominent examples of such systems and they are at the same time of great biomedical interest. The course will cover some classical mathematical population genetics and population dynamics, and also introduce several new approaches. This is reflected in a diverse set of mathematical concepts which make their appearance throughout the course, all of which are introduced from scratch. Topics covered include the quasispecies equation, evolution of HIV, evolutionary game theory, birth-death processes, evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

**Prerequisites / notice**
Prerequisites: Basic mathematics (linear algebra, calculus, probability)

**Literature**


### 636-0017-00L Molecular Evolution, Phylogenetics and Phylodynamics

**W**  4 credits  3G  T. Stadler

**Abstract**
The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

**Objective**
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:

* models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics
* stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:

* epidemiology
* pathogen evolution
* macroevolution of species

**Content**
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics.

The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

**Lecture notes**
Slides of the lecture will be available online.

**Literature**
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

**Prerequisites / notice**
Basic knowledge in linear algebra, analysis, and statistics.
The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g., in cryptography, coding theory, and algorithm theory.

Content
See course description. Available (in English).

Lecture notes

227-1033-00L Discrete Mathematics

Abstract
Content: Mathematical reasoning and proofs, abstraction. Sets, relations (e.g. equivalence and order relations), functions, combinatorics, (un-)countability, graph theory, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi).

Objective
The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g., in cryptography, coding theory, and algorithm theory.

Content
See course description. Available (in English).

Lecture notes

227-1033-00L Molecular Simulation of Biomedical Systems

Abstract
This course covers molecular simulation with emphasis on biomolecular and biophysical applications. The course is divided into two parts: (1) the fundamentals of molecular simulation and computer physics, including an introduction to computational methods, and (2) advanced topics in biomolecular simulations. The course is accompanied by weekly computer sessions.

Objective
Understanding the fundamentals of molecular simulation and computer physics, including an introduction to computational methods and advanced topics in biomolecular simulations.

Content
This course covers the fundamentals of molecular simulation and computer physics, including an introduction to computational methods and advanced topics in biomolecular simulations. The course is accompanied by weekly computer sessions.

Literature
S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites / notice
Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

227-1037-00L Introduction to Neuroinformatics

Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina, and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions.

Objective
Understanding the characteristics of neuromorphic circuit elements.

Content
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina, and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions.

Literature
S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites / notice
Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

529-0004-00L Computer Simulation in Chemistry, Biology and Physics

Abstract
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Objective
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes
Available (copies of powerpoint slides distributed before each lecture)

Literature
See: www.ccs.ethz.ch/education/CSCBP

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.ccs.ethz.ch/education/CSCBP

529-0733-00L Enzymes

Abstract
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Objective
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Content
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Lecture notes
A script will not be handed out.
Gene Technology

Y. Barral

This course focuses on the concepts of classical and modern genetics and genomics. The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Prerequisites:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Lecture notes
Skript "Gene Technology" by Prof. Dario Neri

Microbiology (Part I)

W. D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer

Practical aspects of microbiology are covered, including bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. The course is based on common concepts and will introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Material
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Lecture notes
Updated handouts will be provided during the class.

Literature
Current literature references will be provided during the lectures.

Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Prerequisites:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Objectives
- Understanding of structure-function relationships in proteins and in protein folding.
- Detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Current topics: References will be given during the lectures.

Lecture notes
Skript "Gene Technology" by Prof. Dario Neri

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Prerequisites:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Lecture notes
Skript "Gene Technology" by Prof. Dario Neri

Concepts of modern genetics and issues in gene technology and genome science.

Prerequisites:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Lecture notes
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Prerequisites:
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- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Lecture notes
Skript "Gene Technology" by Prof. Dario Neri
Introduction to mathematical optimization

The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

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

Information about relevant literature will be given in the lecture.

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

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes

No lecture notes, but slides will be made available on the course webpage.

Literature


Prerequisites / notice

Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences

Number of participants limited to 60.

Abstract

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice

Fundamentals of Probability, Fundamentals of Computational Modeling

Applications (Research Projects)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>262-0500-00L</td>
<td>Lab Rotation in Experimental Biology</td>
<td>O</td>
<td>3</td>
<td>6A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract

Flexible, short research project (lab rotation) with an emphasis on experimental biology.
The course provides a practical overview of experimental biology research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.

**262-0600-00L Lab Rotation in Computer Science**
- **ECTS:** 3
- **Type:** O
- **Hours:** 6A
- **Lecturers:**

Flexible, short research project (lab rotation) with emphasis on computer science/theory.

**Objective:**
The course provides a practical overview of computer science research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.

**Content:**
Students learn to transfer and apply their knowledge by working independently in the laboratory or on projects. By applying knowledge acquired from the core and advanced courses, and the Methods of Computer Science course, students gain insight into different research areas.

### Compulsory Electives in Humanities, Social and Political Sciences

#### Recommended GESS compulsory elective courses (Type B) for D-INFK

- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses

### Compulsory Electives in Humanities, Social and Political Sciences

#### Master Thesis

**Number**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>262-0800-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Objective:**
The Master Thesis is the result of an independent scientific research and/or constructive development project in the chosen area of specialization.

**Content:**
The program concludes with a Master thesis of 6 months duration that includes a written report and an oral presentation. The topic of the thesis can be chosen according to the student's interests in the field of computational biology/bioinformatics.

### Course Units for Additional Admission Requirements

*The courses below are only available for MSc students with additional requirements.*

#### 252-0002-AAL Data Structures and Algorithms

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract:**
This course is about fundamental algorithm design paradigms (such as induction, divide-and-conquer, backtracking, dynamic programming), classic algorithmic problems (such as sorting and searching), and data structures (such as lists, hashing, search trees). The connection between algorithms and data structures is explained for geometric and graph problems.

**Objective:**
An understanding of the design and analysis of fundamental algorithms and data structures.

**Content:**
The objective of this course is to teach students how to come up with a correct algorithm and prove its correctness. This course emphasizes the importance of the connection between algorithms and data structures. The topics covered in this course are primarily designed for C++ programming.

**Literature:**
Andrew Koening and Barbara E. Moo: Accelerated C++, Addison-Wesley, 2000
Bjarne Stroustrup: The Design and Evolution of C++, Addison-Wesley, 1994

#### 406-0242-AAL Analysis II

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract:**
Mathematical tools of an engineer

**Objective:**
Mathematics as a tool to solve engineering problems, mathematical formulation of problems in science and engineering. Basic mathematical knowledge of an engineers.

Content

Literature
Textbooks in English:
- J. Stewart: Multivariable Calculus, Thomson Brooks/Cole
- V. I. Smirnov: A course of higher mathematics. Vol. II. Advanced calculus
- M. Akveld, R. Sperb, Analysis II, vdf
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

406-0603-AAL  Stochastics (Probability and Statistics)  E- 4 credits  9R  M. Kalisch
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student’s t Distribution
Ch 9: Distributions of Two Variables
From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435
  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

Computational Biology and Bioinformatics Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

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

ECTS
European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
### Diploma Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0 credits</td>
<td></td>
<td>J. Leuthold</td>
</tr>
</tbody>
</table>

**Abstract**
The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

**Objective**
Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

**Content**
- *Topic 1: Structure of a Scientific Text* (The Title, the author list, the abstract, State-of-the Art, the “in this paper” paragraph, the scientific part, the summary, Equations, Figures).
- *Topic 2: Power Point Presentations.*
- *Topic 3: Citation Rules and Citation Software.*
- *Topic 4: Guidelines for Research Integrity.*

**Literature**
- ETH "Citation Etiquette", see www.plagiate.ethz.ch.

**Prerequisites / notice**
Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
<th>Diploma Thesis</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>227-3001-00L</td>
<td>Diploma Thesis</td>
<td>O</td>
<td>12 credits</td>
<td>36D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Abstract**
The Diploma of Advanced Studies finishes with a 3-months diploma thesis which is directed by a professor of the department ITET. Students prove their ability to conduct independent scientific research on a specific research problem, using skills and knowledge acquired during the program. The thesis includes a written report and an oral presentation.

**Objective**
see above

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**DAS in Information Technology and Electrical Engineering - Key for Type**

<table>
<thead>
<tr>
<th>Letter</th>
<th>Eligibility</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td>W+</td>
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**Key for Hours**

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<tr>
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<td>lecture</td>
<td>P</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
</tr>
</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
DAS Military Sciences
This program is taking place every Second Year. The next realization of this 2 semester program: Autumn Semester 2016.

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr</td>
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<tr>
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<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>Z</td>
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<tr>
<th>Symbol</th>
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<tr>
<td>G</td>
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<td>exercise</td>
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<td>S</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Pharmacology and Toxicology I

**Type:** W  
**ECTS:** 2 credits  
**Hours:** 2V  
**Lecturers:** U. Quitterer

### Abstract
The two-semester lecture course will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action and therapeutic use of the important classes of drugs. The lectures are intended for students of pharmaceutical sciences.

### Objective
The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.

### Content
Topics include disease-relevant macroscopic, microscopic, pathobiochemical and functional disturbances of specific organs and organ systems. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicology, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacootherapy will be covered.

### Lecture notes
Für jede Vorlesung wird ein Skript abgegeben, das eine Zusammenfassung mit den wichtigsten Stichpunkten beinhaltet.

### Literature
- Recommended reading:  
  Klaus Aktories, Ulrich Förstermann, Franz Hofmann, Klaus Starke.  
  Allgemeine und spezielle Pharmakologie und Toxikologie.  
  11. überarb. Auflage - 1216 Seiten  
  2013; Urban & Fischer bei Elsevier, München  

- Heinz Lüllmann, Klaus Mohr, Lutz Hein  
  Pharmakologie und Toxikologie.  
  Arzneimittelwirkungen verstehen - Medikamente gezielt einsetzen  
  17. Auflage - 666 Seiten  

- Comprehensive overview:  
  Heinz Lüllmann, Klaus Mohr, Lutz Hein.  
  Taschenatlas der Pharmakologie.  
  6th edition - 394 Seiten  

- English version  
  Heinz Lüllmann, Klaus Mohr, Lutz Hein.  
  4th edition - 408 pages  

- The classic textbook in Pharmacology:  
  Goodman and Gilman’s The Pharmacological Basis of Therapeutics  
  Laurence Brunton, Bruce Chabner, Bjorn Knuollman.  
  12th edition - 1808 Seiten  

### Prerequisites / notice
Voraussetzungen: Abschluss Grundstudium

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## Clinical Microbiology

**Type:** W  
**ECTS:** 1 credit  
**Hours:** 1V  
**Lecturers:** K. Lucke

### Abstract
Thorough knowledge of major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

### Objective
Thorough knowledge of all major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

### Content
Basics and principles of clinical microbiology:  
- host-pathogen interaction  
- symptoms and diagnosis of major bacterial pathogens  
- therapeutic regimens commonly used against bacterial disease  
- major aspects of medical mycology, virology and parasitology  
- epidemiology

### Literature
- Brock, Mikrobiologie, Pearson, 13. aktualisierte Auflage  
- Kayser F. et al., Medizinische Mikrobiologie, Thieme, Stuttgart, New York  
  Aktuellste Auflage (derzeit 12. Auflage 2010)

### Prerequisites / notice
Basic knowledge of biochemistry, general microbiology, immunology

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## Gene Technology

**Type:** W  
**ECTS:** 2 credits  
**Hours:** 2G  
**Lecturers:** D. Neri

### Abstract
The aim of the lecture course is to provide a solid overview of the science and issues in gene technology and genome science.  
Topics: Antibody phage technology, protein modification technology, genome projects, genome sequencing, transcriptomics, proteomics and SNP technology. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.

### Objective
The course will provide a solid overview of the science and issues in gene technology and genome science.
1. Antibody phage technology
   The antibody molecule
   V genes, CDRs, basics of antibody engineering
   Principles of phage display
   Phagemid and phage vectors
   Antibody libraries
   Phage display selection methodologies
   Other phage libraries (peptides, globular proteins, enzymes)
   Alternative screening/selection methodologies
   DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
   Homo- and hetero-dimerization of proteins
   Chemical modifications of proteins
   Radioactive labeling of proteins
   Kinetic association and dissociation constants
   Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   Protein cloning and expression
   Functional Genomics
   Sequencing genomes and novel sequencing methods
   Genetic disorders: discovery and pharmaceutical implications
   Transcriptomics
   Proteomics
   Principles of Cancer
   Principles of Vaccine Development
   Principles of Gene Therapy

4: Pharmaceuticals: Focus on Discovery
   Chemical Libraries
   Protein Therapeutics
   Consideration on pharmacokinetics and half-life extension

Lecture notes
Skript "Gene Technology" by Prof. Dario Neri
535-0830-00L
Pharmaceutical Immunology
W 2 credits 2G  D. Neri, C. Halin Winter
Abstract
Get Students familiar with basic Immunological concepts of pharmaceutical relevance.
Objective
Get Students familiar with basic Immunological concepts of pharmaceutical relevance.
Content
Chapters 1 - 11 of the Janeway's ImmunoBiology, by Kenneth Murphy (8th Edition; Garland).
Literature
Janeway's ImmunoBiology, by Kenneth Murphy (8th Edition).

Paperback
[www.garlandscience.com]

535-0421-00L
Galenical Pharmacy I
W 2 credits 2G  J.C. Leroux, B. A. Gander
Abstract
Principles and technologies for the manufacturing of dosage forms and drug delivery systems. Knowledge of pharm. excipients, materials, containers, liquid and semi-solid dosage forms, their production, function, quality and application. Comprehension of molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dosage forms.
Objective
Knowledge of the most important pharmaceutical excipients, materials, containers, liquid and semi-solid dosage forms, of their production, function, quality, stability and application. Comprehension of the molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in disperse dosage forms.
Content
Introduction and overview of important fundamentals, principles and technologies for the development and manufacturing of dosage forms and drug delivery systems. Overview of the most important pharmaceutical excipients and polymers, their structure, properties and processing; importance of materials properties for containers. Pharmaceutical solvents, fundamentals of solubility and solubilization of drugs. Water treatment processes, sterilization techniques and quality requirements of pharmaceutical water. Parenteral dosage forms and liquid ophthalmics. Surfactants, micelle formation and colloidal systems. Liquid suspensions and emulsions. Stabilization measures in dosage forms.
Literature
C.-D. Herzfeldt und J. Kreuter (Hrsg.) Grundlagen der Arzneiformenlehre, Springer Verlag, Berlin 1999
H. Leuenberger (Hrsg.) Martin - Physikalische Pharmazie, Wissenschaftliche Verlagsgesellschaft, Stuttgart 2002
R. Voigt, Pharmazeutische Technologie, 10. Auflage, Deutscher Apotheker Verlag, Stuttgart, 2006

Prerequisites / notice
Language: German and English

535-0250-00L
Biotransformation of Drugs and Xenobiotics  W 1 credit 1V  S.D. Krämer
Abstract
Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.
Objective
Goals: knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.
Content
Major reactions of biotransformation. Major enzymes and reaction partners involved in the biotransformation of drugs and xenobiotics.
Lecture notes
Biotransformation of drugs and xenobiotics
Pharmacoepidemiology and Drug Safety

Abstract
Introduction of principles of pharmacoepidemiology and epidemiology in addressing drug related questions in the population and of epidemiologic perspectives for health care management. In parallel appropriate tools to critique pharmacoepidemiologic studies in medical literature will be given and applied.

Objective
To familiarize participants with the principles of pharmacoepidemiology and epidemiology in addressing drug related questions with concern to the use, effects and risks of medicinal products in a large population.

To introduce participants to fundamental statistical, economic and epidemiological concepts and methods.

To provide the appropriate tools to critique pharmacoepidemiologic studies in the literature and to critically read and understand papers in the medical literature which relate to drug benefits, risks, and costs.

To address controversial topics in drug use and benefit-risk assessment, and to critically appraise the outcome of drug therapy.

To equip participants with skills to facilitate further studies in these areas.

Content
The contribution of epidemiology to the study of drug uses, effects and risks:
- Pharmacoepidemiology study methodologies, concepts and strategies,
- Detection and identification of unintended drug effects (pharmacovigilance),
- Quantifying unintended effects and drug interactions,
- Bias and confounding by indication,
- Drug utilization

Pharmacoepidemiology and outcome assessment of drug therapy.

Meta-analysis in pharmacoepidemiology.

Pharmacoepidemiology and regulatory decision making in drug safety

Lecture notes
This course will be a combination of formal lectures, group discussions and self-directed project work. Course material will be taught through seminars, case studies and group projects. Reading material and scripts will be given for each week.

Literature
A reading list pertinent to the course will be provided during the course.

Methodological references
Strom B; Pharmacoepidemiology, 3rd ed. Wiley, Chichester, 2000
Rothman K, Greenland S; Modern Epidemiology, 2nd ed. Lippincott, Philadelphia, 1998
Mann R, Andrews E; Pharmacovigilance, Wiley, Chichester, 2003

Therapeutic Proteins

Abstract
In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.

Objective
Students know and understand:
- basic mechanisms and regulation of the immune response
- the pathogenic mechanisms of the most important immune-mediated disorders
- the most frequently used expression systems for the production of therapeutic proteins
- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

Content
The course consists of two parts:

In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenetic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.

The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

Lecture notes
Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

Literature
- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

535-0030-00L  Therapeutic Proteins  W  3 credits  3G  C. Halin Winter, D. Neri

Second Series of Courses

Compulsory Block Courses

535-5501-00L  Applied Pharmacology  O  6 credits  7G  P. Wiedemeier, S. Erni, B. Falch, K. Fünfschilling

Abstract
Overview of the most important clinical pictures: symptoms, recognition, differentiation, pharmacotherapy for the most important general and special medical indications. Groups of pharmaceutical compounds, active pharmaceutical ingredients, proprietary medicinal products: mechanisms of action, contraindication, therapeutic patterns, side effects, interactions.

Objective
Students have a thorough knowledge of all clinical pictures and their symptoms regarding outpatient treatment. They know the main groups of indications including active pharmaceutical self-medication and ingredients, mechanisms of action, pharmacokinetics, pharmacodynamics and dosage. They are also able to identify the relevant side effects and interactions.

Content
Pathophysiology of selected clinical pictures and their main symptoms and clinical parameters. Recognition of alarm symptoms and distinction between pharmaceutical self-medication and the need for medical treatment. Detailed coverage of the pharmacotherapy of all fields of indication encountered in outpatient treatment. Outlining of therapeutic strategies and patterns with regard to suitable pharmaceutical compounds, active pharmaceutical ingredients and representative range of proprietary medicinal products. Discussion of the most important mechanisms of action, contraindications, side effects and interactions.

535-5502-00L  Pharmaceutical Manufacturing in Small Quantities  O  3 credits  3G  J. Fröhlich, H. Hartenberg, C. Meier

Abstract
Hands-on course in pharmaceutical manufacturing in the pharmacy according to "GMP regulations for small quantities" defined in the pharmacopoeia: Design and practical approach in compounding of formulas using the most important dosage forms including their risks and quality assurance.
Students are able to manufacture, to package, to quality-control and document pharmaceutical compounding on their own, "lege artis" and according to GMP regulations, using the appropriate techniques. They know the most important properties of active ingredients and excipients frequently used. They achieve the necessary knowledge including the relevant literature and other sources of information, as well as the legal requirements regarding pharmaceutical manufacturing in small quantities.

Content

To impart knowledge about the principal techniques and processes in the manufacturing of pharmaceuticals in small quantities (formulas), focusing on the design, manufacturing, quality assurance and risk based self-appraisal including the patient specific dispensing. During the practical training periods: by means of pharmaceutical relevant examples the design, the planning, the manufacturing including the correct use of the equipment, the in-process control, the packaging and the quality assurance are practiced for various dosage forms and recipes. Quality assurance and control are mainly risk adapted considering as well hygiene regulations according to current pharmaceutical practice. The participants will thus improve their general GMP knowledge and skills.

535-5503-00L Institutional Pharmacy ◆ O 3 credits 7G P. Wiedemeier, J. Beney, M. Lutters, I. S. Vogel Kahmann

Abstract

Organisation of institutional environments (emergency hospitals), with special focus on the medication process and institutional pharmaceutical care (continuum of care).

Objective

Students understand the concept of continuum of care and its practical implementation. They know the medication process within an institutional environment. They are able to find the necessary information and deal with problems in connection with pharmaceuticals, to evaluate them and to communicate and documentate their findings adequately. They know how a hospital is organised (procedures, possible problems), responsibilities of the different members of the staff and, most importantly, what the function of a hospital pharmacy is.

Content

Principals of the organisation of institutional environments (emergency hospitals), with special focus on medication processes and institutional pharmaceutical care (circulation of medication, continuum of care). Hygiene regulations, medical products, applications, drug formularies, patient files, SOAP notes, kardex study. Participation at interdisciplinary visits, internal trainings and doctors' reports as well as visitation of the emergency room. Drug interaction, generic substitution, quality management and pharmacovigilance.

535-5504-00L Basics of Practical Pharmacy ◆ O 6 credits 7G P. Wiedemeier, S. Erni, B. Falch, K. Fünfschilling

Abstract

Introduction to managed care systems (Pharmaceutical Care und Public Health); problems with regard to therapy and approaches to solutions, service, first aid and medicinal products. Methods of illness prevention and health promotion. Important additional assortments including complementary medicine. Law and economy in everyday pharmacy, structures of the national health care system.

Objective

Students know the most important concepts and methods of pharmaceutical care of patients with regard to OTC and Rx-only drugs as well as the essential concepts and methods of public health, prevention and health care. They master the basic rules concerning the pharmaceutical triage and their implications. For the clinical pictures covered during the course, they are able to make therapeutic plans or accompany and optimize doctor's orders. Students show an adequate understanding of the rights and duties of pharmacists as medical personnel regarding medical care and service within the framework of the Swiss health care system. They are capable of handling important medical products and instructing patients about their use. Students have the necessary basic skills and applications of first aid and emergency medicine. They know the essence, chances and limits with reference to additional assortments, therapeutic options like phytotherapy, complementary medicine, veterinary pharmacy and non-medical methods of healing. Students have the essential knowledge of legal aspects and regulations concerning pharmacists and know the basics of business administration.

Content

Pharmaceutical Care; possibilities of pharmaceutical care of patients regarding OTC and Rx-only drugs in the officinal pharmacy. Good pharmaceutical triage in practice, introduction to the pharmaceutic validation of prescriptions, recognition of medicinal, patient related, therapeutic problems and the finding of solutions: Choice of therapy (OTC), accompanying and optimizing therapies (Rx), compliance, correct administration of drugs, cooperation with other medical professions in the field of outpatient treatment. Traditional and proactive pharmaceutical service.; development of adequate means of documentations of intervention and consultation as well as pharmaceutical follow-up care. Public health: role and possibilities of official pharmacies as partners within the Swiss health care system: primary health care, prevention, campaigns, early detection, instruction and mediation, referral to doctors. Needs of customers, patients and employees, and social interaction. Significance of the medical profession (illness, suffering, promotion of health and well-being). Basic training in first aid, emergency medicine and wound care. Medical products: handling of important applications and instruction of patients. Important and additional forms of therapy and assortments: phytotherapy, complementary medicine, veterinary pharmacy, non-medical methods of healing. Economy and law in everyday pharmacy: overview of the Swiss legal system. Relevant legal framework, jurisdiction and regulations and their meaning with regard to quality assurance for practicing pharmacists. Basics of finance and accounting as well as personnel management and insurance matters. Organisation and competencies of the various partners within the Swiss health care system, focusing on the intermediate position and the role of pharmacists as part of the medical community.

DAS Preparation for the Swiss Federal Examination in Pharmacy - Key for Type

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

Key for Hours

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

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Doctoral and Post-Doctoral Courses

### Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
064-0003-15L | Postgraduate Colloquium on the History and Architecture (N. N.) | W | 3 credits | 2K | I. Heine-Greenberg

**Abstract**
The Postgraduate Colloquium mainly addresses doctoral students of the Chair. It is aimed at presenting and further discussing the current research, thus focusing on the argumentation and verification of contextual and methodical questions. The Colloquium provides a basis for exchange and further education and to establish and promote networking.

**Objective**
The Colloquium focuses on the presentation and further discussion of the current research of doctoral students. It concentrates on the discussion and verification of contextual and methodical questions and provides a basis for exchange and networking among the participants.

**Content**
Die Themenschwerpunkte der jeweiligen Veranstaltung richten sich nach den präsentierten Forschungsarbeiten. Inhaltlich korrespondieren sie mit den Forschungsschwerpunkten der Professur.

**Prerequisites / notice**
Mehrtägiges Kolloquium. Veranstaltungszeit und -ort nach Vereinbarung.

| Number | Title | Type | ECTS | Hours | Lecturers |
--- | --- | --- | --- | --- | ---

**Abstract**
Lecturers and doctoral students of the chair report about their experiences and insights in the application of methods concerning their research and the scientific publications thereof.

**Objective**
The seminar seeks to provide students with a differentiated knowledge of methods in the field of the History of Art and Architecture.

**Prerequisites / notice**
The seminar addresses the fellows of the Doctoral Program in History and Theory of Architecture. All other doctoral students of the Faculty of Architecture are welcome.

| Number | Title | Type | ECTS | Hours | Lecturers |
--- | --- | --- | --- | --- | ---
064-0009-15L | Research Colloquium in Architecture and Urbanism (M. Angélil) | W | 3 credits | 1K | M. Angélil

**Abstract**
This colloquium is open to doctoral candidates in fields related to Architecture and Urbanism. Its focus will be on contemporary topics in urbanism and will involve two or three one-day sessions over the course of the semester, each of which will be attended by an invited scholar.

**Objective**
The sessions will involve brief presentations of dissertation work by the participants followed by discussions with the guests.

**Prerequisites / notice**
Space is limited and participation is subject to approval from the organizers.

| Number | Title | Type | ECTS | Hours | Lecturers |
--- | --- | --- | --- | --- | ---
064-0011-15L | PhD Talks - Perspectives and Methods of Architectural Research (L. Stalder) | W | 3 credits | 2K | L. Stalder

**Abstract**
This course addresses to PhD's and researchers of D-ARCH as well as to all interested persons coming from adjacent fields of humanities and cultural studies.

**Objective**
The Colloquium focuses on the presentation and further discussion of the current research of doctoral students. It concentrates on the discussion and verification of contextual and methodical questions and provides a basis for exchange and networking among the participants.

**Content**
Die Themenschwerpunkte der jeweiligen Veranstaltung richten sich nach den präsentierten Forschungsarbeiten. Inhaltlich korrespondieren sie mit den Forschungsschwerpunkten der Professur.

**Prerequisites / notice**
Mehrtägiges Kolloquium. Veranstaltungszeit und -ort nach Vereinbarung.

| Number | Title | Type | ECTS | Hours | Lecturers |
--- | --- | --- | --- | --- | ---

**Abstract**
Introduction to methodological approaches in the history and theory of architecture; presentation and discussion of individual doctoral projects.

**Objective**
The doctoral students analyze critically relevant approaches in the history and theory of architecture and discuss fundamental questions with regard to their individual research projects, to produce and hand in their proposals.

**Content**
The two-semester course in the first year of the doctoral program in the history and theory of architecture has a twofold objective: First, reading sessions on central approaches in the history and theory of architecture provide a methodological basis for the doctorate at the Institute gta. Secondly, by both, reading sessions and presentation and discussion sessions on the individual research projects, the doctoral students get support in the production of the proposal which they work on and which they have to present after the first year.

**Prerequisites / notice**
Languages: German and English

| Number | Title | Type | ECTS | Hours | Lecturers |
--- | --- | --- | --- | --- | ---
064-0015-15L | PhD Colloquium Theory of Information Technology for Architects | W | 2 credits | 2K | L. Hovestadt

**Abstract**
Information technology plays an increasingly important role in research. To meet this challenging development, it is not only important to acquire respective skills, but also to consider and understand information technology in what sets it apart from other gestalts of technics (like mechanics, dynamics, or thermodynamics).

**Objective**
The aim of this colloquium is to counter an observable tendency, that proportional to the degree in which students master practical skills in computing, they increasingly submit uncritically, in their understanding and framing of problems, to the dictation of schemata and templates implemented by technical systems.

**Content**
The starting point for this colloquium is to comprehend computing not in terms of skills, but as a literacy which we can experience emerging today. Like in the case of writing as well, computing cannot exhaustively be reduced to either logics, grammar, arithmetics, or analytics. Rather, computation, if comprehended as a literacy, relates to any of the established categories of learning and raises questions of an architectonic kind. This colloquium draws from the principal richness of cultural forms of knowing and learning and thematizes approaches to formulate a theoretical stance on information technology for architects which is driven by and resting on the actual reality of computability today. In this, it is complementary to those theory courses on technology offered by the historical disciplines at ETH.

**Prerequisites / notice**
To benefit from this course, you should have a practical affinity to technics, as well as an abstract interest in information technology in its comprehensive cultural context.

| Number | Title | Type | ECTS | Hours | Lecturers |
--- | --- | --- | --- | --- | ---
862-0002-14L | Research Colloquium History of Knowledge (HS 2015) | W | 2 credits | 1K+1A | M. Hampe, A. Kilcher, K. M. Espahangizi, D. Gugerli,

**Abstract**
Only for MAGPW students, D-GESS PHD and D-ARCH

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The colloquium of the ZGW focuses on present developments, debates and perspectives in the field of history of knowledge. On the second and fourth date there will be public events in the Cabaret Voltaire. Check the program on www.zgw.ethz.ch.

The colloquium deals with the general problems, questions and methods of the interdisciplinary research field "The History of Knowledge". Knowledge has become one of the existential conditions of modern societies and it increasingly determines their dynamics. Therefore, it is getting more and more relevant to develop a differentiated analysis of the epistemic, social and cultural constraints of the production, circulation and the decay of knowledge. In addition, the colloquium asks after the cultural and ethical resonances of knowledge not only within science but also in relation to art, literature, technology, everyday life, and so on.

Content points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K.Espahangizii).

Free childcare available.

064-0017-15L NSL Doctoral Colloquium: Methods in Urban and Landscape Studies

Course data: Time and place will follow in due time.

Abstract
Advanced PhD candidates of urban studies, urban and landscape design and urban sociology report about their experiences and insights in the concrete application of methods utilized for their research and scientific publications. Discussion of ongoing individual work, methodological questions, critical perspectives on urban and landscape design and city's relation to society.

Objective
The seminar seeks to provide participants with a differentiated knowledge of methods in the field of the urbanism. Furthermore, it provides a platform to exchange contemporary urban research experiences across disciplinary boundaries, drawing from different geographies of knowledge production. Possible meta-themes include modes of data assessment in urban studies, ways of progressing from hypothesis to synthesis, and research by design as method.

Content
The format of HS 15 will provide an overarching methodological meta-theme, to be defined prior to the event. One external guest critic will be invited. In this case, each presentation will conclude with a discussion round, providing sufficiently detailed feedback for every doctoral candidate.

Prerequisites / notice
The seminar is joint-organized by the chairs of Prof. Kees Christiaanse, Pro. Dr. Christian Schmid, Pro. Dr. Marc Angélii and Prof. Hubert Klumpner as one full-day event in the academic semester.

The will comprise different formats, alternating with the responsible chair.

Participants in both cases will be expected to submit single-page abstracts of their papers in advance and to make a presentation of app. 20 minutes at the colloquium. The discussion rounds will be moderated by the organizing professor and the invited guests.

Enrolment on agreement with the lecturer only.


Number of participants limited.

Abstract
The programme revolves around the so-far untapped resource desert sand and the question of how to activate its potential as an alternative building material. The E4D winter school will be composed of 30 master and doctoral students of different disciplines related to the topic from ETH Zurich and from other academic institutions. They will be joined by faculty members and external experts.

Objective
The E4D winter school aims to develop an integrated vision to a global challenge of today's construction industry: the non-usability of desert sand. The programme of the E4D Winter School aims at developing alternative methods to activate the so-far unusable resource of desert sand for construction and other applications: (i) bio-cementation, (ii) sintering and (iii) 3D printing.

Content
Sand is the most used raw material for the production of goods on our planet. It is found in concrete, glass, computers, detergents and even toothpaste. But sand is a finite resource: what took millions of years to come into being through erosion and sedimentation, man is mining at rivers and ocean coasts in a so-far unknown speed. Sand is the megastar of the industrial and digital era - our culture is literally built upon this resource. But sand is not equal to sand: The construction industry requires grain sizes and rough shapes that are only found in river beds, lakes and the oceans. Over the turn of millions of years, mountains gradually eroded into gravel, sand and dust. Eventually, rainfalls carry these particles through existing watercourses to the sea. Sand is mostly composed of quartz, a mineral form of silicon dioxide. It is one of the most abundant materials on the earth surface and also one of the strongest. These properties make it valuable to various industries.

Desert sand on the other hand is presently unsuitable to the construction industry: Gradual wind erosion polishes the sand particles into round and even forms and therefore reduces their friction capacity; desert sand is simply too fine and spherical in shape to act as a high-friction aggregate in a concrete matrix.

Prerequisites / notice
Open for students of all Departments of ETH!

Taking place from 9 to 28 January 2016 at the TU Berlin Campus in El-Gouna, Egypt.

Costs: CHF 500, including board and accommodation. All participants are responsible for organising and financing their own domestic or international travel to El Gouna.

The Engineering for Development (E4D) Winter School 2016 will invite 30 master and doctoral students from different disciplines related to the topic of the winterschool. Applicants will be selected based on their academic record and previous work experiences.

Applicants must send a one-page CV and one-page letter of motivation in PDF format stating their interest, to Mrs. Patricia Heuberger, patricia.heuberger@sl.ethz.ch

Deadline: 30 September 2015
Notification: 20 October 2015


### Doctoral Department of Architecture - Key for Type

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

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<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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ECCTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Additional Courses

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<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>102-1227-15L</td>
<td>Advanced Life Cycle Assessment (HS15)</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>C. L. Mutel</td>
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**Abstract**
A seminar on current topic in life cycle assessment. In the fall of 2015, the focus is on assessment of complex systems. We will look a number of topics, including input/output tables, optimization, and linking LCA with physical or economic models.

**Objective**
To improve ones understanding of life cycle assessment, and the broader issues in modeling, improving, and understanding sustainability assessments.

**Content**
The first hour of class is an interactive student presentation with discussion and class participation; each student is expected to present once, either alone or with one other student. The second half of class is devoted to a practical exercise of the concepts introduced and examined in the first half.

**Literature**
Everyone is expected to read one or two scientific articles or manuscripts each week, to be provided by the instructor.

**Prerequisites / notice**
Students should be familiar with either life cycle assessment, environmental science, or economic modeling. This seminar is intended to be primarily for Ph.D. students.

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### Doctoral Department of Civil, Environmental and Geomatic Engineering - Key for Type

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### ECTS
European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
To become proficient in reading scientific literature, to understand how to look at publications, to understand them and to be able to put them in context. The course focuses on themes from ecology and evolution, notably on studies on adaptation of organisms, their evolutionary history, or on current and controversial topics will be discussed and studied.

The actual list of theme papers will be proposed anew for every year. Students then choose a topic and prepare themselves for a general discussion with their colleagues and peers. In the process, current and controversial topics will be discussed and studied. The actual content, i.e. the theme papers, will be determined and allocated to the participants at the start of the course each year.

The course gives an introduction to the development and anatomical structure of nervous systems. Furthermore, it discusses the basics of cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the cellular neurophysiology and neuropharmacology. Finally, the nervous system is described on a system level with a particular emphasis on the visual system.

The course is meant for doctoral students of the Neuroscience Center Zurich (ZNZ). Requirements: Knowledge of ecology and evolution, e.g., lectures during basic and advanced study period. The course is meant for advanced and PhD students.

The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.

For doctoral students of the Neuroscience Center Zurich (ZNZ).


The goal is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

The objective of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of molecular neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

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Abstract | The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Objective | The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content | The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Lecture notes | Handouts during the class

Literature | Recommendations for text books will be covered in the class

Prerequisites / notice | Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

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<tr>
<th>Course Code</th>
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<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>M. Dettling</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning &quot;good practice&quot; that can be applied in every student's own projects and daily work life.</td>
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<tr>
<td>Objective</td>
<td>The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.</td>
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<tr>
<td>Content</td>
<td>The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.</td>
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<tr>
<td>Literature</td>
<td>Faraway (2005): Linear Models with R</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.</td>
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</tbody>
</table>

227-1035-00L | Dynamical Systems in Biology | W | 6 credits | 2V+1U | R. Stoop |
| Abstract | This lecture uses the concepts from dynamical systems (Course: "Computable Chaos in Dynamical Systems") for the description of salient phenomena in complex examples from population dynamics, neuroinformatics and system biology. A particular focus is on the concept of limit cycle solutions and their coupling. |
| Objective | Applying concepts from nonlinear dynamics to biological systems. Combining theoretical modeling with supporting computer simulations. |

551-1615-00L | NMR Methods for Studies of Biological Macromolecules | W | 1 credit | 1S | G. Wider |
| Prerequisites: | Basic knowledge in biological NMR spectroscopy. |
| Abstract | Seminar series on technical aspects of high resolution nuclear magnetic resonance (NMR) spectroscopy with biological macromolecules. |
| Objective | Introduction and discussion of advanced methods for recording and analysis of NMR data with biological macromolecules. |
| Content | Seminar series on technical aspects of high-resolution nuclear magnetic resonance (NMR) spectroscopy with biological macromolecules. |

551-1619-00L | Structural Biology | W | 1 credit | 1K | R. Glockshuber, F. Allain, N. Ban, K. Locher, E. Weber-Ban, G. Wider, K. Wüthrich |
| Abstract | The course consists of a series of research seminars on Structural Biology, Biochemistry and Biophysics, given by both scientists of the National Center of Competence in Research (NCCR) in Structural Biology and external speakers. Information on the individual seminars is provided on the following websites: http://www.structuralbiology.uzh.ch/edusc002.asp http://www.biol.ethz.ch/dbiol-cal/index |
| Objective | The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics. |

851-0180-00L | Research Ethics | W | 2 credits | 2G | G. Achermann |
| Particularly suitable for students of D-BIOL, D-CHAB, D-HEST |
| Abstract | This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences. |
| Objective | The main goal of this course is to enhance the student's ability to: - recognize and identify ethical issues and conflicts, - analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter. Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level. |

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access;
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

Abstract
About 5 talks on applied statistics.

Objective
See how statistical methods are applied in practice.


Content
There will be about 5 talks on how statistical methods are applied in practice.
This is no lecture. There is no exam and no credit points will be awarded. The current program can be found on the web:
http://stat.math.ethz.ch/events/zukost
Course language is English or German and may depend on the speaker.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Description</th>
<th>Credits</th>
<th>Type</th>
<th>Instructors</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1109-00L</td>
<td>Seminars in Microbiology</td>
<td>E-</td>
<td>0</td>
<td>M. Aebi, H.M. Fischer, W.D. Hardt, J. Piel, J. Vorholt-Zambelli</td>
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<tr>
<td></td>
<td>Seminars by invited speakers covering selected microbiology themes.</td>
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<tr>
<td></td>
<td>Discussion of selected microbiology themes presented by invited speakers.</td>
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<tr>
<td>551-0030-01L</td>
<td>Doctoral Thesis</td>
<td>E-</td>
<td>0</td>
<td>Professors</td>
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<tr>
<td></td>
<td>Doctoral Thesis</td>
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<tr>
<td>401-0620-00L</td>
<td>Statistical Consulting</td>
<td>E-</td>
<td>0</td>
<td>M. Kalisch, L. Meier</td>
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<tr>
<td></td>
<td>The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons.</td>
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<td></td>
<td>Advice for analyzing data by statistical methods.</td>
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<td></td>
<td>Students and researchers can get advice for analyzing scientific data, often for a thesis.</td>
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<td></td>
<td>We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data!</td>
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<tr>
<td></td>
<td>This is not a course, but a consulting service. There are no exams nor credits.</td>
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<td></td>
<td>Contact: <a href="mailto:beratung@stat.math.ethz.ch">beratung@stat.math.ethz.ch</a> . Tel. 044 632 2223. See also <a href="http://stat.ethz.ch/consulting">http://stat.ethz.ch/consulting</a></td>
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<td></td>
<td>Requirements: Knowledge of the basic concepts of statistics is desirable.</td>
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<tr>
<td>551-0512-00L</td>
<td>Current Topics in Molecular and Cellular Neurobiology</td>
<td>W</td>
<td>2</td>
<td>U. Suter</td>
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<tr>
<td></td>
<td>Number of participants limited to 8.</td>
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<td></td>
<td>The course is a literature seminar or &quot;journal club&quot;. Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.</td>
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<td></td>
<td>The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.</td>
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<td>You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).</td>
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<td>Presentations will be made available after the seminars.</td>
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<td></td>
<td>We cover a range of themes related to development and neurobiology. Before starting your preparations, check with Jorge Pereira (<a href="mailto:jorge.pereira@biol.ethz.ch">jorge.pereira@biol.ethz.ch</a>), who helps you with finding an appropriate paper.</td>
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<td>You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).</td>
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<tr>
<td>551-0737-00L</td>
<td>Experimental Ecology: Evolution and Ecology</td>
<td>W</td>
<td>2</td>
<td>S. Bonhoeffer</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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<td></td>
<td>Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population biology.</td>
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<td></td>
<td>Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in other groups.</td>
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<td></td>
<td>Scientific talks and discussions on changing subjects.</td>
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<td>For information and details: <a href="http://www.eco.ethz.ch/news/zis">http://www.eco.ethz.ch/news/zis</a></td>
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<td>or contact: <a href="mailto:Lehre-eve@env.ethz.ch">Lehre-eve@env.ethz.ch</a></td>
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<tr>
<td>551-1509-00L</td>
<td>Research Ethics and Biopatents</td>
<td>W</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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<td></td>
<td>Introduction to research ethics and patenting for Ph.D. students in the life science area.</td>
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<td></td>
<td>To raise student's attention to and interest in ethical issues related to the work of a life-scientist and to discuss how to deal with such issues;</td>
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<td></td>
<td>To provide a general overview on intellectual property, specifically on the patent system. Special regard is paid to details and specialities of patents in biology.</td>
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<td></td>
<td>To achieve these goals, introducing lectures, discussions of case studies in groups and in the plenum are foreseen.</td>
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<td></td>
<td>A. Research Ethics</td>
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<td></td>
<td>- What is Ethics: Introduction to ethical theories and moral reasoning</td>
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<td></td>
<td>- Ethical debates in genetotechnology: Discussion of the Asilomar conference and GMO-debate</td>
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<td>- Research ethics: Discussion of ethical issues in scientific research and its publication</td>
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<td>- Case studies: Group discussions of ethical dilemmas related to research in life sciences</td>
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<td>- Patents in Biology: Special aspects</td>
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<td></td>
<td>- Case study</td>
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<td>Detailed literature lists for the different topics of the course will be provided in the script/handout.</td>
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<tr>
<td>551-0509-00L</td>
<td>Current Immunological Research in Zürich</td>
<td>E-</td>
<td>0</td>
<td>R. Spörri, M. Detmar, C. Halin Winter, W.D. Hardt</td>
</tr>
<tr>
<td></td>
<td>The goals of the transferable skill course «Research Ethics &amp; Biopatents» are:</td>
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<tr>
<td></td>
<td>A. to raise student's attention to and interest in ethical issues related to the work of a life-scientist and to discuss how to deal with such issues;</td>
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<td></td>
<td>B. to provide a general overview on intellectual property, specifically on the patent system. Special regard is paid to details and specialities of patents in biology.</td>
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<td></td>
<td>To achieve these goals, introducing lectures, discussions of case studies in groups and in the plenum are foreseen.</td>
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<td></td>
<td>A. Research Ethics</td>
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<td>- What is Ethics: Introduction to ethical theories and moral reasoning</td>
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<tr>
<td></td>
<td>- Ethical debates in genetotechnology: Discussion of the Asilomar conference and GMO-debate</td>
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<td>- Research ethics: Discussion of ethical issues in scientific research and its publication</td>
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<td></td>
<td>- Case study</td>
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</table>

This monthly meeting is a platform for Zurich-based immunology research groups to present and discuss their ongoing research projects. At each meeting, three PhD students or Postdocs from the participating research groups present an ongoing research project in a 30 min seminar followed by a plenary discussion.

The aim of this monthly meeting is to provide further education for master and doctoral students as well as Postdocs in diverse topics of immunology and to give an insight in the related research. Furthermore, this platform fosters the establishment of science- and technology-based interactions between the participating research groups.

Presentation and discussion of current research projects carried out by various immunology-oriented research groups in Zurich.

RNA Biology Lecture Series II: Non-coding RNAs: Biology and Therapeutics

This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

Micro RNAs; computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; nucleic acid-based drugs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; tRNA biology.


Basic knowledge of cell and molecular biology.

Doctoral Department Biology - Key for Type

<table>
<thead>
<tr>
<th>W</th>
<th>Eligible for credits</th>
<th>O</th>
<th>Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

ECTS  European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td></td>
<td>This seminar will feature invited lectures about recent advances and developments in systems biology, including topics from biology, bioengineering, and computational biology.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>To provide an overview of current systems biology research.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
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<td></td>
<td></td>
<td>The final list of topics will be available at <a href="http://www.bsse.ethz.ch/education/">http://www.bsse.ethz.ch/education/</a>.</td>
</tr>
</tbody>
</table>

#### Course Catalogue of ETH Zurich

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0309-00L</td>
<td>Advances in Molecular Biotechnology</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

### Doctoral Department of Biosystems Science and Engineering - Key for Type

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

### Key for Hours

- **V** lecture
- **G** lecture with exercise
- **U** exercise
- **S** seminar
- **K** colloquium

- **P** practical/laboratory course
- **A** independent project
- **D** diploma thesis
- **R** revision course / private study

### ECTS

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Doctoral Department of Chemistry and Applied Biosciences

► Doctoral and Post-Doctoral Courses

★★ Doctoral Studies in Inorganic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0169-00L</td>
<td>Instrumental Analysis</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>D. Günther</td>
</tr>
<tr>
<td>Abstract</td>
<td>Group seminar on elemental analysis and isotope ratio determinations using various plasma sources</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Developments in plasma mass spectrometry and alternative plasma sources</td>
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</tr>
<tr>
<td>529-0198-00L</td>
<td>Main Group Element and Coordination Chemistry</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. Grützmacher</td>
</tr>
<tr>
<td>529-0199-00L</td>
<td>Inorganic and Organometallic Chemistry</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>C. Copéré, H. Grützmacher, D. Günther, M. Kovalenko, A. Mezzetti, A. Togni</td>
</tr>
</tbody>
</table>

529-0545-00L    | Micro- and Nanostructures: Laser Applications in Research and Industry | W    | 2    | 2V    | T. Lippert                         |

Abstract
Introduction to the fundamentals of lasers and their applications with an emphasis on micro- and nano-structuring. Several applications which are still in the research state, will be discussed together with industrial applications, such as micro lithography and laser welding. Other aspects are the materials that are applied in these applications, e.g. photoresists, and their functioning.

Objective
Introduction to the fundamentals of lasers and their applications with an emphasis on micro- and nano-structuring. Several applications which are still in the research state, e.g. non-optical lithographies, will be discussed together with industrial applications, such as micro lithography and laser welding. Other aspects are the materials that are applied in these applications, e.g. photoresists, and their functioning.

Content
Introduction to lasers. Overview of micro- and nanotechnology, micro lithography, photoresists: classical types and new developments, laser cutting and welding, laser cleaning, laser ablation, polymer ablation: designed polymers, lasers and surfaces, laser spectroscopy, laser chemical vapor deposition, pulsed laser deposition (PLD), special materials by PLD, alternative structuring methods.

Lecture notes
The script (a copy of the slides) will be handed out during the first lecture.

Literature

★★ Doctoral Studies in Organic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0280-00L</td>
<td>Analytical Chemistry Seminar</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>R. Zenobi, P. S. Dittrich</td>
</tr>
</tbody>
</table>

Abstract
Analytical Chemistry Seminar
Presentation and discussion of current research topics in analytical chemistry

Objective
Introduction to the fundamentals of lasers and their applications with an emphasis on micro- and nano-structuring. Several applications which are still in the research state, will be discussed together with industrial applications, such as micro lithography and laser welding. Other aspects are the materials that are applied in these applications, e.g. photoresists, and their functioning.

Content
Introduction to lasers. Overview of micro- and nanotechnology, micro lithography, photoresists: classical types and new developments, laser cutting and welding, laser cleaning, laser ablation, polymer ablation: designed polymers, lasers and surfaces, laser spectroscopy, laser chemical vapor deposition, pulsed laser deposition (PLD), special materials by PLD, alternative structuring methods.

Lecture notes
The script (a copy of the slides) will be handed out during the first lecture.

Literature

★★ Doctoral Studies in Physical Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0490-00L</td>
<td>Computer Simulation</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>P. H. Hünlenberger, S. Riniker</td>
</tr>
</tbody>
</table>

Abstract
Weekly seminar programme on special topics in theoretical and quantum chemistry. Talks delivered by PhD students and PostDocs as well as by external speakers.

Objective
Advanced course for PhD students and postdoctoral fellows

Content
Current research topics in theoretical chemistry

Lecture notes

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electron Spectroscopy</td>
<td>W</td>
<td>1</td>
<td>2S</td>
<td>F. Merkt</td>
</tr>
<tr>
<td>Theoretical Chemistry, Molecular Spectroscopy and Dynamics</td>
<td>W</td>
<td>1</td>
<td>2S</td>
<td>F. Merkt, M. Quack, M. Reiher, R. Signorell, H. J. Wörner</td>
</tr>
<tr>
<td>Nuclear Magnetic Resonance Seminar</td>
<td>E-</td>
<td>0</td>
<td>3S</td>
<td>B. H. Meier</td>
</tr>
<tr>
<td>Introduction to the Construction of Measurement Devices in Physical Chemistry</td>
<td>W</td>
<td>2</td>
<td>2P</td>
<td>B. H. Meier</td>
</tr>
<tr>
<td>Seminar in Computational Chemistry C4</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. P. Lüthi, P. H. Hünenberger, M. Reiher, S. Riniker</td>
</tr>
<tr>
<td>Seminar on Special Problems in Physical Chemistry</td>
<td>W</td>
<td>1</td>
<td>3S</td>
<td>M. Quack</td>
</tr>
<tr>
<td>Advanced High Resolution Molecular Spectroscopy</td>
<td>W Dr</td>
<td>1</td>
<td>1V</td>
<td>S. Albert</td>
</tr>
<tr>
<td>Safety and Environmental Technology of Chemical Processes and Products</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>K. Hungerbühler, C. A. Baumele, C. Bogdai, E. Capdon Garcia, M. Scheringer, N. von Götz</td>
</tr>
<tr>
<td>Chemical Process Technology</td>
<td>W</td>
<td>1</td>
<td>2S</td>
<td>M. Morbidelli</td>
</tr>
<tr>
<td>ICB Seminars on Chemical and Biochemical Engineering</td>
<td>W</td>
<td>1</td>
<td></td>
<td>R. Gunawan</td>
</tr>
<tr>
<td>Prerequisites / notice Group meeting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice Nuclear magnetic resonance spectroscopy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice Theoretical chemistry, molecular spectroscopy and dynamics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice Nuclear magnetic resonance spectroscopy</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Prerequisites / notice Introduction to the Construction of Measurement Devices in Physical Chemistry</td>
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<tr>
<td>Prerequisites / notice Physical Chemistry</td>
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<tr>
<td>Prerequisites / notice Seminar in Computational Chemistry C4</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice Seminar on Special Problems in Physical Chemistry</td>
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<tr>
<td>Prerequisites / notice Laser Seminar</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice Advanced High Resolution Molecular Spectroscopy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice Safety and Environmental Technology of Chemical Processes and Products</td>
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<tr>
<td>Prerequisites / notice Chemical Process Technology</td>
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</tr>
<tr>
<td>Prerequisites / notice ICB Seminars on Chemical and Biochemical Engineering</td>
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</tr>
</tbody>
</table>
Objective
Students are expected to attend all seminars in one academic year, and should register at the beginning of each seminar. Additionally they must deliver a two page written report at the end of the year describing the topics covered, main conclusions, and interrelationships between the different themes.

Content
The ICB seminar series covers the umbrella of diverse research activities encompassed within the institute, including catalysis, functional materials, polymer engineering, separations, microfluidics, process design, and systems engineering. This series was founded with the aim of promoting cross-disciplinary scientific discourse and interaction with other distinguished groups working worldwide, and is targeted at individuals who have made outstanding contributions within their fields. Each year, around 7 distinguished scientists and technologists will be invited to speak on topics of current interest in Chemical and Biochemical Engineering. PhD students are particularly encouraged to attend in order to broaden their perception and enrich their scientific horizons.

151-1049-00L Seminar in Fundamentals of Process Engineering
Only for master and doctoral students of Process and Chemical Engineering.
Abstract
This seminar covers actual subjects from the specific research areas of the laboratory of transport processes and reactions.
Objective
Scientific discussion on actual research topics
Content
The contents are announced through the group's webpage.
Lecture notes
No textbook

★★ Doctoral Studies in Polymer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0585-00L</td>
<td>Reactivity in Micelles and Vesicles</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>P. J. Walde</td>
</tr>
</tbody>
</table>

Abstract
Discussion of different aspects of the chemical reactivity in micelles and in vesicles (liposomes) as polymeric compartments.
Objective
Deeper understanding of micelles and vesicles as self-organizing reaction compartments.
Content
With a few selected recent examples, properties of micelles and vesicles will be discussed with respect to applications as reaction compartments.
Lecture notes
no script

★★ Doctoral Studies in Pharmaceutical Sciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-2000-00L</td>
<td>Seminar für Mitarbeiter</td>
<td>W</td>
<td>0 credits</td>
<td>2S</td>
<td>G. Schneider</td>
</tr>
</tbody>
</table>

Abstract
Weekly group seminar, in which members of the research team present and discuss the results of their projects and selected reports from the current scientific literature.
Objective
Participants learn to present scientific studies and discuss own results in greater context.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
State-of-the-art information on drug discovery and development by experts from academia and industry.
Objective
State-of-the-art information on drug discovery and development.
Content
Seminars series of the Institute of Pharmaceutical Sciences. Experts from academia and industry report on relevant topics.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>535-0903-00L</td>
<td>RNA Club Zurich</td>
<td>E-</td>
<td>0 credits</td>
<td>1S</td>
<td>J. Hall</td>
</tr>
</tbody>
</table>

Abstract
The RNA Club Zurich was originally founded to promote the interaction and collaboration of local research groups and individuals with an interest in RNA biology and chemistry. We organise a series of seminars on cutting edge topics in RNA research with internal and external speakers. Our seminars are held on a monthly basis from April-December.
Objective
The RNA Club Zurich was originally founded to promote the interaction and collaboration of local research groups and individuals with an interest in RNA biology and chemistry. We organise a series of seminars on cutting edge topics in RNA research with internal and external speakers. Our seminars are held on a monthly basis from April-December.
Content
The RNA Club Zurich was originally founded to promote the interaction and collaboration of local research groups and individuals with an interest in RNA biology and chemistry. We organise a series of seminars on cutting edge topics in RNA research with internal and external speakers. Our seminars are held on a monthly basis from April-December.
Lecture notes
Lectures and Optional subjects in MSc Pharmaceutical Sciences

★★ Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0195-00L</td>
<td>Scientific Information Retrieval &amp; Management in Life Sciences and Chemistry</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>O. Renn</td>
</tr>
</tbody>
</table>

Abstract
Students will learn how to effectively retrieve, critically judge, analyze and manage published scientific information - important skill sets in chemistry and life sciences where scientists need to deal with vast amounts of information. The course, being based on practical examples, also covers scientific writing & communication and state-of-the-art technologies for analysis such as text mining.
Objective
Ability to select appropriate, subject-specific databases or tools for a given specific scientific question based on a sound understanding on how a tool or database has been developed and maintained; thus building the personal capacity of doing research effectively and efficiently by integrating scientific information into the research process when needed. Ability to communicate own scientific results using additional distribution channels. Ability to easily write-up the Ph.D. thesis or first paper.
The course has been primarily designed for Ph.D. students, also for the Life Science Zurich Graduate School, but is also open to Master students. In a series of 13 lectures, which always include practical examples (for some lectures an own notebook is required), the use of scientific information is taught not in a database-centric view but corresponding to the steps through which scientific research is conducted - including the dissemination of scientific results. This is particularly interesting for students who are about to write-up their first paper or thesis. Students will learn about the different types of information resources and tools, get an insight into the numerous databases and tools that exist and how those are built and maintained, enabling them to critically judge the value and trustworthy of information resources. Additionally, they will learn how to communicate their own scientific results properly, using also additional measures that are reflected by alternative metrics.

The following topics are covered:
1. The World of Scientific Publishing
2. Searching and Retrieving Scientific Information Using Search Engines and Using Literature Databases
3. Searching and Retrieving Scientific Information Using Subject-specific Databases in Chemistry
4. Searching and Retrieving Scientific Information Using Subject-specific Databases in Life Sciences
5. Tools for Managing the Retrieved Scientific Information
7. Patents
8. Text (Literature) and Data Mining
9. Communicating & Analyzing the Impact of (Your) Science
10. Scientific Writing & Good Scientific Practice

The slide deck and supplementary materials will be made available in the teaching document repository (ILIAS) after each lecture. Additional literature and reference are provided in the course material.

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**Doctoral Department of Chemistry and Applied Biosciences - Key for Type**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Doctoral Department of Earth Sciences

Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-0254-00L</td>
<td>Seminar Geochemistry and Petrology</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>O. Bachmann, M. Schönbächler, C. A. Heinrich, M. W. Schmidt, D. Vance</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Seminar series with external and occasional internal speakers addressing current research topics. Changing programs announced via D-ERDW homepage (Veranstaltungskalender)</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Presentations on isotope geochemistry, cosmochemistry, fluid processes, economic geology, petrology, mineralogy and experimental studies. Mostly international speakers provide students, department members and interested guests with insight into current research topics in these fields.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Wöchentliches Seminar mit Fachvorträgen eingeladener oder interner Wissenschafter, vornehmlich zu Themen der Geochemie, Isotogengeologie, Hydrothermalgeochemie, Lagerstättenbildung, Petrologie, Mineralogie und experimentelle Studien.</td>
</tr>
<tr>
<td>651-1617-00L</td>
<td>Geophysical Fluid Dynamics and Numerical Modelling</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>P. Tackley, M. D. Ballmer, T. Gerya, D. A. May</td>
</tr>
<tr>
<td></td>
<td>Seminar</td>
<td></td>
<td></td>
<td></td>
<td>Seminar series addressing current research topics in Petrology (Magmatic Petrology and Crystalline Geology and Experimental Petrology)</td>
</tr>
<tr>
<td>651-0251-00L</td>
<td>Seminar Petrology</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>M. W. Schmidt, O. Bachmann</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Seminar series with external and occasional internal speakers addressing current research topics in Petrology.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Seminar series addressing current research topics in Petrology (Magmatic Petrology and Crystalline Geology and Experimental Petrology)</td>
</tr>
<tr>
<td>651-4931-00L</td>
<td>Heat and Mass Transfers in Magmatology</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>O. Bachmann</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Heat and mass transfers in the crust control many aspects of the differentiation of our planet, including (1) type of volcanic eruptions we should expect at the surface of our planet, (2) the volcanic/plutonic ratio in the crust, and (3) how volcanic degassing occurs, with important consequences on the climate response following volcanic eruptions.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>The goal of this class is to learn about the modern methods and ideas on heat and mass transfers in magmatology through recently published papers and computer softwares. The class will allow students to explore some of the most challenging concepts in this field, and become familiar with state-of-the-art techniques to model these processes.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>The class will focus mostly on reading recent literature on topics of interests, and will contain some computer exercises to allow students to work by themselves on some well-defined problems.</td>
</tr>
<tr>
<td>651-4123-00L</td>
<td>Earthquake Physics and Numerical Modelling Paper</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>Y. van Dinther</td>
</tr>
<tr>
<td></td>
<td>Discussions</td>
<td></td>
<td></td>
<td></td>
<td>Biweekly paper discussion series on current challenges and state-of-the-art practices in earthquake physics and seismic cycle and geodynamic modeling.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>To understand and evaluate current challenges and state-of-the-art practices in earthquake physics and seismic cycle and geodynamic modeling. Besides obtaining an overview of this field, participants can expect to improve their skills to:</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Exact topics will depend on the research interests and projects of the participants, but are likely to include:</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>PhD or advanced MSc students are expected to present one paper relating to their research interests and read papers discussed by the other students. The grading is based on participation in discussions and the given oral presentations.</td>
</tr>
</tbody>
</table>

Doctoral Department of Earth Sciences - Key for Type

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

Key for Hours

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

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### Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0125-03L</td>
<td>Research Colloquium for Ph.D.-Students and Members of Staff ■ Open for Master students on personal invitation.</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>L. Wingert, M. Hampe</td>
</tr>
<tr>
<td>851-0580-01L</td>
<td>Colloquium Sociology for PhD Students Only for doctoral students sociology. Presentations by doctoral students. Exchange of ideas and for improving doctoral research.</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>A. Diekmann</td>
</tr>
<tr>
<td>851-0585-00L</td>
<td>Rational-Choice-Sociology. Theory and Empirical Applications Rational-Choice-Theory has become one of sociology's general theoretical approaches. The seminar concerns itself with major ideas, concepts and questions involved with the development of a theory. The seminar will also include examples of empirical applications from various fields of sociology. Attain in-depth knowledge and learn about new aspects of Rational-Choice-Theory and its applications. In collaboration with Prof. Dr. Norman Braun, Dr. Thomas Hinz, University of Munich, and Dr. Axel Franzen, University of Cologne. Due to a very limited number of possible participants please register early with the assistant at the Chair of Sociology <a href="mailto:irene.urbanek@soz.gess.ethz.ch">irene.urbanek@soz.gess.ethz.ch</a>. Doctoral students and post-doctoral students will be given priority. The seminar will be held in German. Participants are expected to write a paper or give a presentation.</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>A. Diekmann</td>
</tr>
<tr>
<td>851-0587-00L</td>
<td>CIS Colloquium This seminar is open for staff members based at the Center for Comparative and International Studies, CIS. In this seminar staff members of the Center for Comparative and International Studies (CIS) and external guests present and discuss their research. In this seminar staff members of the Center for Comparative and International Studies (CIS) and external guests present and discuss their research. Presentation and discussion of current research. Distributed electronically.</td>
<td>E-</td>
<td>2</td>
<td>2K</td>
<td>L.E. Cederman, M. Steenbergen</td>
</tr>
<tr>
<td>862-0088-00L</td>
<td>Research Colloquium Science Studies ■ This colloquium is devoted to the introduction into the theory and practice of scientific work. The schedule can be found on the institute's website - <a href="http://www.wiss.ethz.ch/en/teaching/">http://www.wiss.ethz.ch/en/teaching/</a> This colloquium is devoted to the introduction into the theory and practice of scientific work. Papers presented may be in English or German. Students receive 1 credit point for submitted a brief, written commentary on one of the presentations (approx. 5 pages).</td>
<td>E-</td>
<td>1</td>
<td>1K</td>
<td>M. Hagner</td>
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<tr>
<td>851-0587-01L</td>
<td>CIS Doctoral Colloquium In this internal colloquium doctoral students present their work after about 12 months of research. The aim of this colloquium is that the presenters receive feedback on their research at an important stage (a stage at which significant changes of direction, methodology, etc, may still be undertaken) in the PhD process. Presentation of doctoral research. Distributed electronically. Distributed electronically.</td>
<td>W</td>
<td>2</td>
<td>1K</td>
<td>P. Holtrup Mostert</td>
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<tr>
<td>851-0549-00L</td>
<td>WebClass Introductory Course History of Technology Particularly suitable for students of D-BAUG, D-INFK, D-ITET, D-MATL, D-MAVT. WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>D. Gugerli</td>
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</tbody>
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Data: 06.12.2018 13:04 Autumn Semester 2015 Page 381 of 1432
PhD students will have an opportunity to improve their presentation skills and obtain an important chance to receive feedback both from S. Bechtold.

Weitere Informationen unter https://www.tg.ethz.ch/de/programme/

851-0626-02L PhD Colloquium in Development Economics  W 2 credits 1K I. Günther

Objective
PhD students learn how to present and discuss their own research questions, methods, results and problems. PhD students get familiar with the challenges of empirical research in developing countries.

851-0735-10L Business Law Particularly suitable for students of D-ITET  W 2 credits 2V P. Peyrot

Abstract
The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.

Materialien.

851-0735-09L Workshop & Lecture Series on the Law & Economics of Innovation  W 2 credits 2S A. Bechtold, H. Gersbach, A. Heinemann, G. Hertig

Abstract
This series is a joint project by ETH Zurich and the University of Zurich. It provides an overview of interdisciplinary research on intellectual property, innovation, antitrust and technology policy. Scholars from law, economics, management and related fields give a lecture and/or present their current research. All speakers are internationally well-known experts from Europe, the U.S. and beyond.

Objective
After the workshop and lecture series, participants shall be acquainted with interdisciplinary approaches towards intellectual property, innovation, antitrust and technology policy research. They should also have an overview of current topics of international research in these areas.

Content
The workshop and lecture series will present a mix of speakers who represent the wide range of current social science research methods applied to intellectual property, innovation, antitrust policy and technology policy issues. In particular, theoretical models, empirical and experimental research as well as legal research methods will be represented.

Lecture notes
A comprehensive script will be made available online on the moodle platform.

851-0125-18L Self-Ownership - Philosophical and Juridical  W 3 credits 2G B. Hilmer

Abstract
Rights in Objects are founded by an inalienable Self-Ownership. These Idea ist central for personal rights. We speak of my body, my genes, my name, my portrait, my ideas or ways of expression.

Objective
Participants will make acquaintance with founding texts of the natural rights property concept (John Locke). They will see the connection between inalienable self-ownership, prohibition of slavery, derivative commercial rights and modern personal rights. They will learn about the problems of self-ownership today concerning property in one's body and intellectual property. Critical alternatives to the property paradigm will be discussed.

Participations will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts and orient themselves in current bioethical, juridical and political discussions.

This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

Objective
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

Content
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at "tipping points", multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or "tragedies of the commons" such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.

Prerequisites
Mathematical skills can be helpful.


Abstract
The colloquium is an essential part of the postgraduate programme "history of knowledge" dealing with the history of modern knowledge systems in a broad sense. In the analysis of the various systems of knowledge the programme seeks to combine approaches from the fields of Philosophy, History of Science and Technology as well as Social, Economic and Cultural History.

Objective
The objective of the colloquium is to train the participants in the history of knowledge, to give an insight into different methodological perspectives of all disciplines involved, to practice presentations and develop an understanding of specific problems of interdisciplinary cooperation.

851-0240-16L Current Research on MINT Learning W 1 credit 1K E. Stern, P. Greutmann, E. Hafen, J. Hromkovic, N. Hungerbühler, A. Togni, A. Vaterlaus

Abstract
This colloquium focuses on the presentation of research projects conducted by the professorships participating in the competence center EducETH which concern learning in the STEM subjects. STEM stands for science, technology, engineering, and mathematics. Doctoral students and postdoctoral researchers will present their current projects and theoretical and methodological aspects will be discussed.

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

851-0738-00L Intellectual Property: Introduction W+ 2 credits 2V M. Schweizer

Abstract
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

Objective
The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

851-0738-01L The Role of Intellectual Property in Daily Routine: Practical Introduction W 2 credits 2V C. Soltmann

Abstract
The lecture gives engineering students an overview of the basic aspects of intellectual property. The lecture aims to make participants aware of the various methods of protection and to put them in a position to be able to use this knowledge in the workplace.

Content
Texts by Locke, Nozick, Christman, Otsuka, Rasmussen, Schneider, Stirner, Fichte and Forschner. Founding of property right in self-ownership (Locke), revival of this concept in Nozick and his egalitarian critics. Critique of the concept of self-ownership related to property in one's body. Looking back to the personal self-relatedness that comes up again in Intellectual Property and in modern personal rights.
Objective
In recent years, knowledge about intellectual property has become increasingly important for engineers. In both production and distribution as well as in research and development, engineers are increasingly being confronted with questions concerning the patenting of inventions and the utilisation of patent information. With up to 80% of publicly-available technical information being stored in patents only, it is of great importance for engineers to know the basics of the patent system and to be in a position to be able to extract relevant information from the flood of patent information available. This relates to daily work in industry as well as in research, where protecting inventions has gained in importance.

Patients are also an important source of information - from competitors and potential cooperation partners to the development of markets and the risk of coming into conflict with third party IP rights. Respectively, a knowledge of patents has also become a key qualification at a company's strategic level.

The seminar is customised to the needs of engineers. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.

The seminar contains practical exercises on the use and research of patent information. Basic knowledge on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture 'Protecting inventions in chemistry' will be offered, which is coordinated to the needs of students in these degree programs.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>851-0157-00L</td>
<td>Mind and Brain</td>
<td>3 credits</td>
<td>M. Hagner</td>
</tr>
<tr>
<td>851-0125-41L</td>
<td>Introduction Into Philosophy of Technology</td>
<td>3 credits</td>
<td>O. Müller</td>
</tr>
<tr>
<td>851-0144-15L</td>
<td>The Beginning of Scientific Enquiry - History and Impact of Presocratic Natural Philosophy</td>
<td>3 credits</td>
<td>N. Sieroza</td>
</tr>
<tr>
<td>851-0252-01L</td>
<td>Human-Computer Interaction: Cognition and Usability</td>
<td>3 credits</td>
<td>C. Hölscher, I. Barisić, S. Ognašanovic</td>
</tr>
</tbody>
</table>
This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

Objective
This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with selected usability evaluation methods (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay/report will be required (details to be specified in the introductory session of the course).

851-0252-02L Introduction to Cognitive Science
Number of participants limited to 70. Particularly suitable for students of D-ITET

W 3 credits 2V C. Hölscher, L. Konieczny, T. Thrash

Abstract
The lectures provide an overview of the foundations of cognitive science and investigate processes of human cognition, especially perception, learning, memory and reasoning. This includes a comparison of cognitive processes in humans and technical systems, especially with respect to knowledge acquisition, knowledge representation and usage in information processing tasks.

Objective
Cognitive Views offers human cognition as information processing and provides an inter-disciplinary integration of approaches from cognitive psychology, informatics (e.g., artificial intelligence), neuroscience and anthropology among others. The lectures provide an overview of basic mechanisms of human information processing and various application domains. A focus will be on matters of knowledge acquisition, representation and usage in humans and machines. Models of human perception, reasoning, memory and learning are presented and students will learn about experimental methods of investigating and understanding human cognitive processes and representation structures.

851-0252-03L Cognition in Architecture - Designing Orientation and Navigation for Building Users
Particularly suitable for students of D-ARCH

W 3 credits 2S V. Schinazi, B. Emo Nax, C. Hölscher

Abstract
How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.

Objective
Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they orientize the environment and how they find their way from A to B. Students will also learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking and behavior simulation for design. Students will reflect on the roles of designers and other stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture/planning, engineering, computer science and behavioral science as well as joint students in the relation between design and cognition.

Architecture students can obtain course credit in "Vertiefungsfach" or "Wahlfach".

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB
Number of participants limited to 70. Particularly suitable for students of D-MAVT, D-INF, D-ITET, D-MTEC, D-PHYS.

W 3 credits 2S D. Helbing, S. Biallietti, O. Woolley

Abstract
This course introduces the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Lecture notes
The lecture slides will be presented on the course web page after each lecture.

Literature
Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

Prerequisites / notice
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar is available for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further use and unrestricted use.

862-0089-00L Advanced Colloquium in Literary Studies
Colloquium is designed for advanced and graduated students.

E- 1 credit 1K A. Kilcher

Abstract
The colloquium addresses advanced and graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic complex issues.

Objective
The colloquium addresses advanced and graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic complex issues.

851-0252-05L Research Colloquium Cognitive Science
Prerequisite: Participants should be involved in research in the cognitive science group.

W 1 credit 2K C. Hölscher, V. Schinazi, T. Thrash

Abstract
The colloquium provides a forum for researchers and graduate students in cognitive science to present/discuss their ongoing projects as well as jointly discuss current publications in cognitive science and related fields. A subset of the sessions will include invited external visitors presenting their research. Participants of this colloquium are expected to be involved in active research group.

Objective
Graduate student train and improve their presentation skills based on their own project ideas, all participants stay informed on current trends in the field and have the opportunity for networking with invited scholars.

851-0738-03L Protecting Inventions in Chemistry

W 2 credits 2V C. Soltmann
Looking at the degree of embodiment in cognition and emotion naturally leads to the question how the mind works. What is the nature of 1S

N. Sieroka

Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we

3 credits

K. Stocker

D. Helbing

From Computational Social Science to Global Systems Science serves to better understand the emerging digital society with its close co-

2S

Abstract

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and

2S

Research and development play an important role in chemistry-related technology sectors, such as inorganic chemistry, pharmacy or food

Objective

Investments in the development of new substances and active component in these sectors are traditionally secured by patents because

chemistry.

publicly known inventions, generally chemical substances, may easily be reproduced by others.

In the last years, the know-how about intellectual property has become increasingly important for chemists and engineers. Both in the

production process and in the distribution sector, chemists and engineers are increasingly concerned with questions related to patenting

inventions and the use of patent information. As more than three-quarters of all publicly available technical information is reportedly

available only in patents, it is more and more important for researchers and engineers to be capable of extracting relevant information from

the flood of patents.

Patents are not only a measure to protect investments and inventions in chemistry-related sectors but also an important source of

information about competitors and potential cooperation partners, about the development of markets and the risks of infringing others'

patents. Accordingly, the know-how about patents and patent information has also become a key qualification on the strategic level in

companies and in the area of research.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with

practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired

knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:

- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.
- Special aspects of protecting inventions in chemistry-related sectors, including polymorphs and inventions in the field of nanotechnology.

The seminar contains practical exercises on the use and search of patent information in chemistry-related sectors. Basic know-how on how to

read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent

information will also be provided.

Prerequisites / notice

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, biotechnology, chemical

engineering, chemistry, food science, pharmaceutical sciences.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' will be offered, which is coordinated to the needs of students in these degree programs.

862-0096-00L

Theoretical Philosophy Work in Progress Seminar

Only for History and Philosophy of Knowledge MSc and D-

GESS PhD students.

W 3 credits 1S N. Sieroka

Abstract

In this course themes from theoretical philosophy are discussed which are of particular interest for current MAPGW students. Primary texts

will be read together and the work in progress of the participants (essays, theses) will be presented and discussed.

Objective

This course is aimed at MAPGW students who are particularly interested in theoretical philosophy. The seminar provides an opportunity to
discuss and present on one's own research. The participants learn to critically evaluate primary texts and improve their skills in presenting and
discussing work in progress.

851-0585-41L

From Computational Social Science to Global Systems Science

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

MAVT, D-MTEC, D-PHYS

W 3 credits 2S D. Helbing

Abstract

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and

phenomena together with related empirical, experimental, and data-driven work, (2) combining perspectives of different scientific disciplines
(e.g., sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work.

Objective

Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we
do not understand and cannot control well, thereby causing systemic risks and extreme events.

They should also be able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to
an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-
evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to
the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, ear

gineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

851-0253-00L

Embodied Cognition

Particularly suitable for students of D-CHAB

W 2 credits 2S K. Stocker

Abstract

This seminar offers an introduction to embodiment. Does the representation of thought and emotion depend upon the sensory and motor
system? Highlights: the figurative processing of "go" still evokes voltage changes in foot muscles, conceptualizing time activates the eyes
to look along a mental time line, abstract causality might still be grounded in motor control, emotion shows in the way we walk

Objective

Looking at the degree of embodiment in cognition and emotion naturally leads to the question how the mind works. What is the nature of
human thoughts and emotions? How deeply are they dependent upon features of our physical body as an agent? Do the sensory and
motor system play a physically constitutive role in conceptualizing thought and emotion? We will look at these questions by examining the
degree of embodiment in basic thinking types of our mind (space, time, and causality thinking) as well as in abstract thought (e.g., logical
thinking) and in emotion processing. As will be discussed, the topic of how the mind works is not only of central importance in the
humanities (psychology, linguistics, philosophy, anthropology, education), but is also relevant for parts of the natural and technological
sciences (physiology, neuroscience, medicine, computer science, artificial intelligence). Active participation is expected. Each participant can
choose a topic for which they will give an oral presentation (about 30 min.) and write a related written report (about 3000 words).

851-0306-05L

Literature and Technology - Simulations, Prototypes, Machines

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

W 3 credits 2S
Abstract
Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.

Objective
Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

Content

851-0300-94L
Combinatorics: History of a Method Between Mathematics and Literature
Particularly suitable for students of D-MATH

W 3 credits 2S A. Kilcher

Abstract
Combinatorics is a procedure shared by various disciplines. In mathematics it concerns the calculation of quanta and probabilities, in philosophy the creation of encyclopedic knowledge, in mysticism the achievement of ecstatic experience, in literature, finally, experimental writing. This course investigates these different forms of combinatorics.

Objective
- comparative understanding of combinatorics as a transcultural and transdisciplinary procedure to generate knowledge
- cultural and epistemic history of combinatorics since the medieval ages
- combinatorics in theology, mysticism and occultism
- combinatorics in philosophy and the natural sciences
- combinatorics in literature and literary theory

Content
Kombinatorik, die Verknüpfung von Elementen, tritt als ein Verfahren in unterschiedlichen Disziplinen und Bereichen des Wissens auf: In der Mathematik, wo man sie zuerst vermutet, ermöglicht sie die Berechnung von Anzahlen und Wahrscheinlichkeiten. Zugleich spielt die Kombinatorik auch eine grosse Rolle in der Philosophie (als ein Verfahren zur Erzeugung eines enzyklopädischen Wissens), in der Mystik (zur Erfahrung ekstatischer Erfahrung) und in der Literatur (als ein experimentelles Schreibverfahren). In dem Seminar werden diese vielfältigen Formen und Funktionen von kombinatorischen Verfahren zwischen mathematischer, philosophischer, mystischer und ästhetischer Anwendung verglichen und analysiert.

851-0158-00L
Living at the Expense of Others. Parasites in the History of Science
Number of participants limited to 80.

W 3 credits 2V E. Johach

Abstract
Parasites have a bad reputation. They settle in with other creatures' bodies, they manipulate and deceive them, they live at the expense of others. Such features are not only of biological but also of social, political, and economic importance. The lecture will track the traces of the parasite through the history of biology and medicine and the fields of political economy and cultural theory.

Objective
The course provides insight into the complex and intricate history of the parasite and the various definitions of parasitism. In particular, it will make students aware of the fact that there is no single expert discourse on parasites (such as biology or medicine) which is then transferred to the realm of the social and the political. Instead, it will be considered how and why all these aspects are intertwined when people talk about parasites.

851-0158-01L
Science and Wonder
Number of participants limited to 30.

W 3 credits 2S E. Johach

Abstract
Wonders seem to be perfectly incompatible with science: Superstition and ignorance here, exactness and certitude there. In the seminar we will study this conflictive relation in more detail. Texts will cover a broad historical spectrum ranging from pre-modern cabinets of wonder to the anti-wonder polemics in the 19th century to the current dispute on Intelligent Design.

Objective
Following the notions of "wonder" and the "wonderful" as recurrent themes students will get an overview of the history of the sciences and their specifically modern self-conception. They will gain the expertise to understand arguments and conflicts out of their particular historical context and thereby get inside into the historical variability of objectivity and scholarly standards.

851-0101-47L
Science in the Twentieth Century: A Global Perspective WEBCLASS
Particularly suitable for students of D-MAVT, D-MATH

W 3 credits 2S V. Bharadwaj, B. Schär

Abstract
This course studies the 20th century history of those forms of knowledge framed specifically as science and technology, from a global perspective. It explores how exchanges and relationships between different parts of the world contributed to what is understood as science and "development". In doing so, it considers how the concept of science is entangled with structures of power and domination.

Objective
- to critically consider the concepts of science and knowledge
- to understand how advances in technology and science are historically rooted in European imperial expansion and are connected to global social inequalities in the postcolonial world.
- to understand the historical plurality of forms of knowledge in different parts of the world as well as entanglements between different forms of knowledge
- to systematically reconstruct and reproduce complex arguments (reading-competences)
- to understand, compare and analyse differing approaches to the history of science.
- to enable students to form an educated opinion and participate in discussions on the global history of science and knowledge

851-0145-04L
History and Philosophy of Pharmacy
Particularly suitable for students from D-CHAB.

W 3 credits 2S S. Baier

Abstract
The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts.

Objective
The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts.

851-0309-13L
"Materialmörären": Thomas Mann’s Zauberberg from the Point of View of the History of Knowledge
Number of participants limited to 20.

W 3 credits 2S J. Reidy

Abstract
This seminar is dedicated to Thomas Mann's "Zauberberg", the great Bildungsroman and "Zeitroman" (Mann) from the author's middle period. Mann himself feared that the novel might be intellectually overburdened with contexts and concepts. The seminar will attempt to elucidate these contexts from the point of view of the history of ideas and knowledge and will take into account current research.

Objective
- Students familiarize themselves with one of the great novels of the 20th century in the context of a diligent reading accompanied by the lecturer.
- On the basis of the primary text, the seminar establishes several perspectives grounded in cultural history, the history of knowledge and ideas, economic and social history and the history of medicine.

851-0300-95L
Writing Between Cultures. German-Jewish Literature and Cultural Knowledge 1822-1933

W 3 credits 2V A. Kilcher

Abstract
German-Jewish literature, which includes famous modern authors from Heine to Kafka, is remarkable because it is a cultural double. This lecture course shows the at once productive and problematic dual, transcultural relationship of its history. The key question is how, in this relationship, cultural knowledge is discussed in theoretical, political and literary terms.
Objective: Overview on the history of German-Jewish literature in Germany and Austria between ca. 1822 and 1933.

Content: - Discussion of key text of the most important German-Jewish authors (such as Heine, Börne, Herzl, Kafka, Döblin, Kraus, Roth, Wolfskehl, Lasner-Schüler).
- Analysis of theoretical and cultural reflections in German-Jewish literature, art and culture.
- Answer to the general question: how cultural knowledge was theorized and discussed in (Jewish) modernity.

Literature: Andreas B. Kilcher (Hrsg.): Metzler Lexikon der deutsch-jüdischen Literatur. 2., aktualisierte und erweiterte Auflage, Stuttgart 2012.

851-0125-51L Man and Machine

Objective: Particularly suitable for students of D-CHAB, D-HEST, D-MAVT, D-MATL

Abstract: The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.

Objective: On the one hand models of machines had a heuristic value in research on man, e.g. in Harvey’s discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these models were always criticised, sometimes polemically, because they are supposedly not adequate for man.

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

851-0157-56L Avantgarde-Life: Utopia of the ‘New Man’ Between Science and Technology

Objective: Particularly suitable for students of D-ARCH, D-HEST, D-MTEC.

Abstract: The seminar is fully booked!

At the beginning of the 20th century, the artistic and social avantgarde movements developed visions of a ‘New Man’ with new modes of perception and within new forms of social life. The seminar deals with the scientific, technological, artistic, pedagogical, and political designs for a new living.

Objective: The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It focuses on the correlation of the contemporary scientific and technological developments and the conceptions of a ‘New Man’. The discipline of psychotechnics together with scientific and technological designs of living and working environments formulated visions of new and enhanced ways of human living and perception. In the seminar, we will examine the utopian visions of life in the avantgarde movements. Touching upon the fields of the life sciences, economics, management, progressive education, architecture, and art we will reflect the diverse relations between science, technology, and human living.

851-0300-92L Institutionalisation of Modernity: "Der Sturm", a German Art & Literary Magazine, Edited by Herwarth

Objective: Based on the contributions published between 1910 and 1932 in "Der Sturm", the seminar gives an overview on the unique diversity of literary and cultural movements in Berlin between the turn of the century and the Weimar Republic. Besides the reading of literary texts, the lecture focuses on the aesthetic, philosophical and political discourses of the epoch.

Objective: The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It focuses on the correlation of the contemporary scientific and technological developments and the conceptions of a ‘New Man’. The discipline of psychotechnics together with scientific and technological designs of living and working environments formulated visions of new and enhanced ways of human living and perception. In the seminar, we will examine the utopian visions of life in the avantgarde movements. Touching upon the fields of the life sciences, economics, management, progressive education, architecture, and art we will reflect the diverse relations between science, technology, and human living.

851-0125-48L Wisdom, Certainty, Insecurity

Objective: Wisdom is widely - maybe even universally, at all times and everywhere - regarded as one of the highest virtues. But what constitutes wisdom? And is wisdom compatible with uncertainty? Does a wise person have to be certain or can she be uncertain? These and related questions will be discussed in the seminar to gain an understanding of what wisdom, certainty and uncertainty are.

Abstract: Wisdom is widely - maybe even universally, at all times and everywhere - regarded as one of the highest virtues. But what constitutes wisdom? And is wisdom compatible with uncertainty? Does a wise person have to be certain or can she be uncertain? These and related questions will be discussed in the seminar to gain an understanding of what wisdom, certainty and uncertainty are.

Objective: 1. Analysis and discussion of different interpretations of the virtue “wisdom”.
3. Discussion of the questions what constitutes wisdom today and whether wisdom is a goal of the good life.
4. Examination of the relevance of wisdom in practical and theoretical contexts.

851-0157-57L Classics in the History of Science: Approaches,

Objective: More often than not, classics are known by hearsay; they are quoted, but not read, or re-discovered and re-read selectively, so we can quote them. That holds true for many ‘classics’ in the history of science, too - texts, that is, which have shaped approaches to, and understandings of, science. The aim of this introductory course is to critically read some of these seminal texts.

Abstract: This course is suited for all students with an interest in the history of science and knowledge. Conceived of as an advanced historiographical introduction to the subject, the course is to explore a selection of “classics” in the history of science - some of them well known, others less so. In this course, we shall be as much concerned with the theories and the perspectives on science that were advanced in these various texts as we shall be concerned with the historical circumstances, political meanings and wider cultural contexts of these perspectives.

851-0325-01L Censorship, Caricature and System Criticism : Knowledge of Diversity in the Work of Oskar Panizza

Objective: The seminar is dedicated to the texts of scandal author Oskar Panizza. Especially the dogmas and beliefs of the Christian churches caused in this perception the grievances in society. Other the subject regimented categories such as ethnicity and gender are denounced by Panizza and discussed in his writings in many ways.

Objective: - Acquiring cultural scientific aspects and perspectives of literature and literary history: alterity, ethnicity, gender constructions, social differences, religion, etc.
- Critical analysis of recent research positions and research questions.
- Training problem oriented circumvention of literature and its social functions in historical contexts.
- Developing genre typological and narratological foundations.
- Independent balancing and writing of own research ideas.

851-0125-52L Central Questions in Bioethics
Particularly suitable for students of D-BIOL, D-CHAB, D-HEST, D-MATL, D-MAVT

Objective

851-0125-52L Central Questions in Bioethics

Objective
Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like "Protect the dignity of the living being", or "Respect a person's self-determination"? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account.

851-0125-52L Central Questions in Bioethics

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Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like "Protect the dignity of the living being", or "Respect a person's self-determination"? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account.

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851-0125-52L Central Questions in Bioethics

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851-0125-52L Central Questions in Bioethics

Objective
Cooperation and fairness in encounters with strangers are puzzling behaviors, since they contradict the law of natural selection. Notwithstanding, daily experience as well as field and laboratory studies, all reveal that humans do cooperate and behave fairly. This lecture series is intended to present the main theoretical approaches in economics and psychology to understanding cooperation and fairness to review some of the relevant experimental studies. The seminar lectures will focus on three strategic games: the prisoner's dilemma (PD), the ultimatum game (UG) and the Public Goods (PG) game. The theories to be discussed include: classical game theory, reciprocity theories, altruistic punishment, equity, reciprocity and competition (ERC), inequality aversion (IA), as well as new psychological theory of aspiration levels. The theories' predictions of cooperativeness and fairness in the above mentioned games will be presented and compared using experimental data.

For more information, see: http://www.socio.ethz.ch/studium.html

Groups of 2-3 students will write an essay on a topic to be agreed upon during the course meetings. Students will be requested to submit their paper within one month from the last class meeting. The grades will be delivered within two months after the last class meeting.
C. Jany

Der Unterschied zwischen Natur- und Kulturwissenschaften wird oft anhand ihrer Stellung zur Geschichte charakterisiert: hier strenge method & transhistorical laws, there historically conditioned, and hence relative, understanding. But the discrepancy between transhistorical Immanence and historical constitution figures also within both disciplines. We will discuss precisely this discrepancy.

Objectives
- reflect on the ideal of scientific rigor, as well as the historical constitution of all knowledge;
- question the paradigm of historicity with regard to both the natural sciences and the humanities;
- critical reading of theoretical and literary texts that deal with the tension between scientificity and historicity.

Content
Der Unterschied zwischen Natur- und Kulturwissenschaften wird oft anhand ihrer Stellung zur Geschichte charakterisiert: hier strenge method & transhistorical laws, there historically conditioned, and hence relative, understanding. But the discrepancy between transhistorical Immanence and historical constitution figures also within both disciplines. We will discuss precisely this discrepancy.

Literature
Prerequisites / notice

857-0993-00L Visualizing and Analyzing Spatial Data in Political Science

Abstract
This course introduces students to the analysis of geospatial data for applications in political science. It provides them with the tools and methods necessary for incorporating geospatial data in their own research projects, and guides participants through the entire workflow of creating, viewing, managing, visualizing, and analyzing geospatial data for understanding political phenomena.

Objective
- develop a basic understanding of the problem of cartographic projection;
- collect, create, manipulate, and combine geospatial data for their own research projects;
- visualize geospatial data in maps and interactive applications;
- understand the challenges associated with analyzing geospatial data with statistical tools;
- create, run, and interpret basic spatial econometric models (linear SEM and SAR models).

Requirements:
- Basic understanding of linear regression and simple statistical concepts.
- Interest in quantitative analysis.
- Laptop (Win/Mac/Linux) for exercises.

851-0300-98L History and/or "Rigorous" Science?

Abstract
The difference between the natural sciences and the humanities is often characterized in terms of their relation to history: here rigorous method & transhistorical laws, there historically conditioned, and hence relative, understanding. But the discrepancy between transhistorical Immanence and historical constitution figures also within both disciplines. We will discuss precisely this discrepancy.

Objective
- reflect on the ideal of scientific rigor, as well as the historical constitution of all knowledge;
- question the paradigm of historicity with regard to both the natural sciences and the humanities;
- critical reading of theoretical and literary texts that deal with the tension between scientificity and historicity.

Content
Der Unterschied zwischen Natur- und Kulturwissenschaften wird oft anhand ihrer Stellung zur Geschichte charakterisiert: hier strenge method & transhistorical laws, there historically conditioned, and hence relative, understanding. But the discrepancy between transhistorical Immanence and historical constitution figures also within both disciplines. We will discuss precisely this discrepancy.

Literature
Prerequisites / notice

851-0300-98L History and/or "Rigorous" Science?

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Literature
Prerequisites / notice

857-0093-00L Visualizing and Analyzing Spatial Data in Political Science

Abstract
This course introduces students to the analysis of geospatial data for applications in political science. It provides them with the tools and methods necessary for incorporating geospatial data in their own research projects, and guides participants through the entire workflow of creating, viewing, managing, visualizing, and analyzing geospatial data for understanding political phenomena.

Objective
- view and manage geospatial data in various formats;
- develop a basic understanding of the problem of cartographic projection;
- collect, create, manipulate, and combine geospatial data for their own research projects;
- visualize geospatial data in maps and interactive applications;
- understand the challenges associated with analyzing geospatial data with statistical tools;
- create, run, and interpret basic spatial econometric models (linear SEM and SAR models).

Requirements:
- Basic understanding of linear regression and simple statistical concepts.
- Interest in quantitative analysis.
- Laptop (Win/Mac/Linux) for exercises.
Objective
Designing artifacts is a critically important, if not unique, human cognitive activity. While we have engaged in design activity since we have been human, it has only been an object of study for the past 50 years. The initial focus during the 1960s was on “design methodologies.” This body of work, motivated by large, technically sophisticated, geographically dispersed projects like the Polaris missile project, sought to develop an analytic, mathematically based, teachable doctrine about the design process that would serve the same role for design as the “scientific method” served for science. During the 1980s interest shifted from a normative approach to a descriptive approach, focusing on the cognitive and computational processes of designers. More recently, several researchers are using neuropsychological methodologies to understand the design process.

Learning objectives: to understand the design process from a normative methodological perspective, and descriptive computational, cognitive, and neural perspectives.

Learning outcomes: By the end of the seminar the student should be familiar with these literatures, should be able to discuss relative strengths and weaknesses, and identify what each has contributed to our ability to design, and to our understanding of the design process itself.

851-0252-07L Recent Debates in Social Networks Research
Number of participants limited to 30

Objective
Social Networks research is a highly interdisciplinary fields. For example, scholars in Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics contribute to the development of theories and methods. This course aims at understanding, comparing and structuring recent debates in the field of Social Networks.

851-0101-49L Concepts and Sources of Global History: Young Researchers’ Colloquium

Objective
Social Networks research is a highly interdisciplinary fields. At the end of this seminar, students will understand and be able to compare different subject-specific approaches to social networks research (e.g., from Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics). They will be familiar with recent publications in the field of Social Networks and be able to critically participate in a number of recent debates. Amongst others, these debates touch upon the co-evolution of selection and influence mechanisms, appropriateness of statistical models, generic mechanisms and features of social networks, models for the analysis of dynamic networks.

364-1062-00L Experimental Methods

Objective
This course introduces PhD students into the principles of experimental methods and outlines how to prepare, conduct and evaluate an experiment.

Content
1. Introduction: What are economic experiments and why to use them?
4. Conducting experiments: Instructions, testing, recruiting, sessions.
5. Measuring techniques: Eliciting beliefs, risk attitudes, social preferences.

Books:

Basic Articles:

A reading list with articles for each lecture has been published in ILIAS.
### Doctoral and Post-Doctoral Courses  
#### Health Sciences and Technology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1791-00L</td>
<td>Introductory Course in Neuroscience I</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>J.M. Fritschy, W. Knecht</td>
</tr>
</tbody>
</table>

**Abstract**
The course gives an introduction to the development and anatomical structure of nervous systems. Furthermore, it discusses the basics of cellular neurophysiology and neuropharmacology. Finally, the nervous system is described on a system level with a particular emphasis on the visual system.

**Content**
1) Neuroanatomy I  
2) Neuroanatomy II  
3) Neurogenesis  
4) Axon guidance  
5) Action and language development  
6) Circadian rhythms  
7) Synaptic plasticity  
8) Synaptic transmission  
9) Neural circuits in vivo  
10) Visual pathways and visual processing  
11) Somatosensory system  
12) Vestibular system  
13) Sleep  
14) Learning and Memory, mice and human

**Prerequisites / notice**
For doctoral students of the Neuroscience Center Zurich (ZNZ).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

**Abstract**
The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

**Objective**
This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.

**Prerequisites / notice**

#### Food Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-0005-00L</td>
<td>Public Colloquium in Food Science</td>
<td>E-</td>
<td>1 credit</td>
<td>2K</td>
<td>L. Meile</td>
</tr>
</tbody>
</table>

**Abstract**
This course is based on attendance of public seminars in the field of Food Science provided by invited speakers of the Institute of Food, Nutrition and Health (IFNH). A selected side-topic extracted from these seminars are presented by the students and evaluated by specialists in the particular field.

**Objective**
The main goal for this course is to provide students with topics on current research in Food Science and related fields from which the students have to elaborate and present a more extended topic through literature studies.

**Content**
This course is based on 6-10 seminars/semester announced as "IFNH Seminars" where invited speakers of IFNH professorships are presenting a certain topic related to the work of the professorship inviting the speaker. Students have to attend at least 6 seminars, select a seminar side-topic related to a particular speaker's topic and present this individual topic in the presence of a mall number of selected IFNH specialists at a date which has to be arranged with L. Meile.

**Lecture notes**
No special script

**Literature**
Individual literature

---

**Doctoral Department of Health Sciences and Technology - Key for Type**

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

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<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System
### Doctoral Department of Computer Science


#### Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0912-00L</td>
<td>Experimental Computer Systems</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>T. Gross</td>
</tr>
<tr>
<td></td>
<td>Only for Ph.D. students at the Institute of Computer Systems. All other students need the approval by the lecturer.</td>
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<tr>
<td>Abstract</td>
<td>This graduate seminar provides doctoral students in computer science a chance to discuss their research. Enrollement requires permission of the instructor. Credit units are granted only to active participants.</td>
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<tr>
<td>Objective</td>
<td>Learn how to formulate a research project, how to conduct research and how to improve presentation skills in an academic setting.</td>
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<tr>
<td>Content</td>
<td>The seminar will explore different topics from a research perspective. The seminar is open to assistants of the Department of Computer Science (Informatik), Computer Systems Institute. Others should contact the instructor.</td>
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<tr>
<td>Lecture notes</td>
<td>Supporting material will be distributed during the seminar.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Credit will be given only to those who present a paper/project. No credit for “attendance”.</td>
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<tr>
<td>252-0923-00L</td>
<td>OMS Case Study I</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Norrie</td>
</tr>
<tr>
<td></td>
<td>This doctoral seminar consists of a series of talks and discussions covering the history and foundations of OMS, related work and on-going OMS developments and applications.</td>
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<tr>
<td>Objective</td>
<td>The seminar will explore different topics from a research perspective.</td>
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<tr>
<td>252-0932-00L</td>
<td>Seminar on Cryptography</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>U. Maurer, M. Hirt</td>
</tr>
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<td></td>
<td>Latest Topics in Cryptography will be discussed.</td>
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<tr>
<td>Objective</td>
<td>The seminar will explore different topics from a research perspective.</td>
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<tr>
<td>252-0933-00L</td>
<td>Algorithms and Complexity (HS)</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>J. Hromkovic, P. Widmayer</td>
</tr>
<tr>
<td></td>
<td>The seminar treats selected problems of current interest in the area of algorithms and complexity.</td>
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<tr>
<td>Objective</td>
<td>Develop an understanding of selected problems of current interest in the area of algorithms and complexity.</td>
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<tr>
<td>Content</td>
<td>This seminar treats selected problems of current interest in the area of algorithms and complexity.</td>
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<tr>
<td>Lecture notes</td>
<td>None</td>
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<tr>
<td>Literature</td>
<td>Research papers, to be chosen in the seminar.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Basic understanding of algorithms and complexity.</td>
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<tr>
<td></td>
<td>Only for Computer Science Ph.D. students.</td>
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<tr>
<td>Abstract</td>
<td>An essential aspect of any research project is dissemination of the findings arising from the study. Here we focus on oral communication, which includes: appropriate selection of material, preparation of the visual aids (slides and/or posters), and presentation skills.</td>
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<tr>
<td>Objective</td>
<td>The seminar participants should learn how to prepare and deliver scientific talks as well as to deal with technical questions. Participants are also expected to actively contribute to discussions during presentations by others, thus learning and practicing critical thinking skills.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This doctoral seminar of the Machine Learning Laboratory of ETH is intended for PhD students who work on a machine learning project, i.e., for the PhD students of the ML lab.</td>
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<tr>
<td>252-4202-00L</td>
<td>Seminar in Theoretical Computer Science</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>E. Welzl, B. Gärtnert, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov</td>
</tr>
<tr>
<td></td>
<td>Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.</td>
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<tr>
<td>Objective</td>
<td>The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.</td>
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<tr>
<td>252-1425-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W</td>
<td>6</td>
<td>2V+2U+1A</td>
<td>B. Gärtnert, M. Hoffmann, E. Welzl</td>
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<td>Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)</td>
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<tr>
<td>Objective</td>
<td>The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains.</td>
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<td>Content</td>
<td>In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.</td>
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<td>Lecture notes</td>
<td>Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in R^d, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.</td>
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<td>Prerequisites / notice</td>
<td>Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first seminars of Bachelor Studies at ETH.</td>
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<td>Outlook</td>
<td>In the following spring semester there is a seminar &quot;Geometry: Combinatorics and Algorithms&quot; that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.</td>
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<tr>
<td>263-4203-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>B. Gärtnert, E. Welzl</td>
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<td>This seminar is held once a year and complements the courses Computational Geometry and Geometric Graphs: Combinatorics &amp; Algorithms. Students of the seminar will present original research papers, some classic and some of them very recent. The seminar is a good preparation for a master, diploma, or seminar thesis in the area.</td>
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### 263-4200-00L
**Seminar SAT**

**W**
2 credits
2S
E. Welzl

**Objective**
Goal of this seminar is to study and present, in continuation of the course "Boolean Satisfiability-Combinatorics and Algorithms", research papers from the literature.

**Prerequisites / notice**
To attend the seminar, some basic knowledge in (discrete and computational) geometry and graphs and algorithms is required. Thus, previous participation in some of the courses "Graphs and Algorithms", "Computational Geometry", "Geometric Graphs: Combinatorics & Algorithms", or similar courses is strongly encouraged. It is also possible to take this seminar in parallel to the lecture "Computational Geometry".

### 263-2100-00L
**Research Topics in Software Engineering**

**W**
2 credits
2S
P. Müller

**Objective**
This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.

**Prerequisites / notice**
The seminar builds heavily on the material covered in the course "Boolean Satisfiability-Combinatorics and Algorithms." Successful completion of that course is a prerequisite for participation in the seminar.

### 264-5810-00L
**Programming Languages Seminar**

**W**
2 credits
2S
P. Müller, M. Vechev

**Objective**
Learn about current research results in the area of programming languages, static program analysis, program verification, and related areas; practice of scientific presentations.

**Prerequisites / notice**
The seminar is open to assistants of the Chair of Programming Methodology and the Software Reliability Lab (Department of Computer Science). Others should contact the instructors.

### 264-5800-00L
**Doctoral Seminar in Visual Computing (HS15)**

**W**
1 credit
1S
M. Gross, M. Pollefeys, O. Sorkine Hornung

**Objective**
Learn about current research results in the area of Visual Computing, practice of scientific presentations.

**Prerequisites / notice**
Current research at the IVC will be presented and discussed.

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### Doctoral Department of Computer Science - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<td>O</td>
<td>Compulsory</td>
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<td>P</td>
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<td>R</td>
<td>revision course / private study</td>
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### Key for Hours

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<tr>
<th>V</th>
<th>lecture</th>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>K</td>
<td>colloquium</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Doctoral and Post-Doctoral Courses

A minimum of 12 ECTS credit points must be obtained during doctoral studies. Please discuss your course selection with your PhD supervisor.

### Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
227-0225-00L | Linear System Theory | W | 6 credits | 5G | J. Lygeros, M. Kamgarpour

**Abstract**
The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

**Objective**
By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.

**Content**
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

**Lecture notes**

**Prerequisites / notice**
Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.

227-0389-00L | Advanced Topics in Magnetic Resonance Imaging | W | 0 credits | 1V | K. P. Prüssmann

**Abstract**
This course is geared towards master and PhD students with a focus on bioimaging. It covers advanced topics in magnetic resonance imaging in biennial rotation, including the electrodynamics of MR signal detection, noise mechanisms, image reconstruction, radiofrequency pulse design, RF pulse trains, as well as advanced contrast mechanisms.

**Objective**
see above

227-0417-00L | Information Theory I | W | 6 credits | 4G | A. Lapidoth

**Abstract**
This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

**Objective**
The fundamental of Information Theory including Shannon's source coding and channel coding theorems

**Content**
The entropy rate of a source. Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding. Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity

**Literature**
T.M. Cover and J. Thomas, Elements of Information Theory (second edition)

227-0427-00L | Signal and Information Processing: Modeling, Filtering, Learning | W | 6 credits | 4G | H.A. Loeliger

**Abstract**
Fundamentals in signal processing, detection/estimation, and machine learning.

I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparseness.


**Objective**
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

**Content**


**Lecture notes**
Lecture notes.

**Prerequisites / notice**
Prerequisites:
- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

227-0445-00L | Advanced Mathematical Signal Processing | W | 3 credits | 3G | H. G. Feichtinger

**Block course:**
Starts on October 8 and ends on November 26, 2015
Thursdays 10-12 and 13-16

**Abstract**
Usually Fourier Analysis and Systems Theory emphasize the analogy between the different settings (continuous&discrete, periodic&non-per.). The author proposes a simple approach to generalized functions, based on a Banach space of test functions. The course provides the foundations to Banach Gelfand triples, but also concrete applications in signal processing (time-variant systems, sampling).

**Objective**
Deeper mathematical understanding of the foundations of signal processing and system theory. The setting of Banach Gelfand Triples allows to provide a framework that allows among others to discuss the relations between different settings (e.g. the generalized Fourier transform of functions on the Euclidean space and corresponding FFT-based routines).

**Content**
Time-Frequency Analysis and its discretized version, namely Gabor Analysis have required to develop a family of function spaces (the so-called modulation spaces, introduced by Feichtinger in the 80th) which is different from the usual Lebesgue spaces. There is a smallest space (called $S_0$) and a largest space (namely the dual space), which is a suitable reservoir of generalized functions relevant for the rigorous establishment of basic results in signal processing (sampling theorem, Poisson formula, Fourier inversion, etc.). The course will be centered about the basic properties of the Banach Gelfand triple $(S_0,L_2,S_0')$ (also called rigged Hilbert space), its use for signal processing and systems theory applications. In addition to classical questions we will also discuss the fundamental results of time-frequency analysis (Short-time Fourier transform, Gabor frames, Gabor multipliers, best approximation of operators by Gabor multipliers, identification of slowly varying channels using pilot tones, etc.).

**Lecture notes**
There will be a script related to the course. In fact, material for a book project on the subject is developed while the course is given.

In principle a good understanding of concepts from algebra is sufficient. Of course, basic knowledge about functional analysis (Banach and Hilbert spaces, linear operators and linear functionals) is helpful. We will, however, explain all these concepts as we go along. We will not need background on Lebesgue integration or topological vector spaces (as usually required for the treatment of distributions).

227-0689-00L | System Identification | W | 4 credits | 2V+1U | R. Smith

**Notice**
Course Catalogue of ETH Zurich

Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data. 

To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity.

Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models.

Predictive, open-loop, black-box identification methods. Time and frequency domain methods. Subspace identification methods.

Optimal experimental design, Cramer-Rao bounds, input signal design.

Parametric identification methods. On-line and batch approaches.


Control systems (227-0216-00L) or equivalent.

Seminar in Electromagnetics

Selected topics of the current research activities of the IFH and closely related institutions are discussed.

Have an overview on the research activities of the IFH.

Randomized Algorithms and Probabilistic Methods

Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistical knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous machine learning algorithms on real world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

No lecture notes, but slides will be made available on the course webpage.


### Key for Hours

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### Doctoral and Post-Doctoral Courses

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<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-1036-00L</td>
<td>Empirical Innovation Economics</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Wörter</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>The course focuses on important factors that drive the innovation performance of firms, like innovation capabilities, science-industry relationships, environmental policy and it shows how innovation activities relate to firm performance and to the technological dynamic of industries. Hence, the course provides an understanding of the relationship between technical change and industrial dynamics.</td>
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<td><strong>Objective</strong></td>
<td>The course provides students with the basic skills to understand and assess empirically the technological activities of firms and the technological dynamics of industries.</td>
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<td><strong>Content</strong></td>
<td>The course consists of two parts. Part I provides an introduction into important topics in the field of the economics of innovation. Part II consists of empirical exercises based on the KOF Innovation Data. In part I we will learn about ...a) market conditions that encourage firms to invest in R&amp;D (Research and Development) and develop new products. ...b) the role of universities for the technological activities of a firm (technology transfer). ...c) how technologies diffuse among firms. ...d) how the R&amp;D activities of firms are affected by economic crises and how firms finance their R&amp;D activities. ...e) how we can measure the returns to R&amp;D activities. ...f) how (environmental) policies affect the technological activities of a firm. In part II we will use the KOF Innovation Survey Data in order to assess empirically the technological activities of firms referring to the topics introduced in part I.</td>
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<td><strong>Lecture notes</strong></td>
<td>Will be provided in the course</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Literature will be presented in the course. For an introduction into the economics of innovation see G.M. Peter Swann, The Economics of Innovation - an Introduction, Edward Elgar, 2009. For an overview of empirical innovation studies see W.M. Cohen (2010): Fifty Years of Empirical Studies of Innovation Activities and Performance, in: B.H Hall, N. Rosenberg (eds.), Handbook of Economics of Innovation, volume 1, Elsevier, pp. 129-213.</td>
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<td><strong>Prerequisites / notice</strong></td>
<td>Course is directed to advanced Master-Students and PhD Students with an interest in empirical work.</td>
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<td>364-0531-00L</td>
<td>CER-ETH Research Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>2S</td>
<td>H. Gersbach, A. Bommier, L. Bretschger, W. Mimra</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>Research Seminar of Center of Economic Research CER-ETH</td>
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<td><strong>Objective</strong></td>
<td>Understanding cutting-edge results of current research in the fields of the CER-ETH Professors.</td>
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<td><strong>Content</strong></td>
<td>Referate zu aktuellen Forschungsergebnissen aus den Bereichen Ressourcen- und Umweltökonomie, theoretische und angewandte Wachstums- und Aussenwirtschaftstheorie sowie Energie- und Innovationsökonomie von in- und ausländischen Gastreferierenden sowie von ETH-internen Referierenden.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Bitte spezielle Ankündigungen beachten.</td>
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<td>364-0553-00L</td>
<td>Innovation in the Digital Space</td>
<td>W</td>
<td>1 credit</td>
<td>1G</td>
<td>G. von Krogh</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>The purpose of this course is to review and discuss issues in current theory and research relevant to innovation in the digital space.</td>
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<td><strong>Objective</strong></td>
<td>Through in-depth analysis of published work, doctoral candidates will identify and appraise theoretical and empirical studies, formulate research questions, and improve the positioning of their own research within the academic debate.</td>
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<td><strong>Content</strong></td>
<td>The Internet has a twofold impact on the way individuals and firms innovate. First, firms increasingly draw on digital technology to access and capture innovation-relevant knowledge in their environment. Second, individuals, firms, and other organizations extensively utilize the Internet to create, diffuse, and commercialize new digital products and services. During the past decade, theory and research on innovation in the digital space has flourished and generated extensive insights of relevance to both academia and management practice. This has brought us better understanding of working models, and some fundamental reasons for innovation success or failure. A host of new models and research designs have been created to explore the innovation in the digital space, but these have also brought out many open research questions. We will review some of the existing streams of work, and in the process explore a new research agenda.</td>
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<tr>
<td><strong>Format</strong></td>
<td>The course is organized in one block of 2 days. The course is a combination of pre-readings, presentations by faculty and students, and discussions. The students prepare presentations of papers in order to facilitate analysis and discussion.</td>
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Dynamic models and workhorses in macroeconomics

We will learn how to craft models, how to present our own research and improve our analytical skills.

Doctoral Workshop: Astute Modelling

In this workshop, ongoing research is presented and the criteria and guidelines for astute modelling of economic, political, and social situations are discussed.

Prerequisite: Students are expected to attend the course 364-0559-00L "Dynamic Macroeconomics (Doctoral Course)", before registering for this workshop.

In this workshop, ongoing research is presented and the criteria and guidelines for astute modelling of economic, political, and social situations are discussed. We will learn how to craft models, how to present our own research and improve our analytical skills.

Prerequisites / notice
Students are expected to attend the doctoral course "Macroeconomic Dynamics" before registering for this workshop.

PhD Course: Applied Econometrics

In this course, we will address three blocs of selected problems: (i) estimation of fixed and random effects panel data models for single equations and systems of equations; (ii) estimation of models with endogenous treatment effects or sample selection; (iii) estimation of models with interdependent data (so-called spatial models).

Students will be able to program estimation routines for such problems in STATA and apply them to data-sets. They will be given a data-set and will have to work out empirical problems in the context of a term paper.

Objective
The main agenda of this course is to familiarize students with the estimation of econometric problems with three alternative types of problems: (i) estimation of fixed and random effects panel data models for single equations and systems of equations; (ii) estimation of models with endogenous treatment effects or sample selection; (iii) estimation of models with interdependent data (so-called spatial models).
For panel data analysis, I will rely on the book:

For sample selection and endogenous treatment effect analysis, I will rely on the book:

For spatial econometrics:
I will mostly use papers.

I will prepare a script (based on slides), covering all topics.

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**364-0517-00L Urban and Spatial Economics**

**Abstract**
This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.

**Objective**
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

**Content**
- **Outline of Lectures**
  - Topic 1: Why do cities exist?
  - Topic 2: The Basic Muth-Mills model
  - Topic 3: The New Economic Geography
  - Topic 4: Business demand for land and Von Thünen's model
  - Topic 5: Urban spatial structure
  - Topic 6: Land use control
  - Topic 7: City size and city growth
  - Topic 8: Traffic externalities and congestion
  - Topic 9: Public transport

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**Textbook**
- Cities, agglomeration and spatial equilibrium by E. L. Glaeser, 2008, Oxford University Press.
- The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.

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**364-0581-00L Microeconomics Seminar (ETH/UZH)**

**Abstract**
Research Seminar research papers of leading researchers in Microeconomics are presented and discussed.

**Objective**
Research Seminar research papers of leading researchers in Microeconomics are presented and discussed.

**Content**
Invited Speakers present current research in Microeconomics.

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**364-1013-00L Managerial Cognition**

**Abstract**
The primary objective of this module is to introduce some of the major theoretical threads and controversies in the field of managerial cognition. A secondary objective is to help understand the process of empirical research that has the potential to make an impact on research and management practice.

**Objective**
The module will seek to provide:
1) Exposure to key theoretical streams in the area.
2) Familiarity with the issues, methods, findings and gaps in the area.
3) Skills in finding insight in the literature.
4) Skills in critiquing the literature, defining research problems and proposing empirical research in this area.

**Content**
- Session 1: Introduction to the field of managerial cognition
- Session 2: Methods to study managerial cognition
- Session 3: Sensemaking, Mindfulness and Attention
Session 1: Introduction


Prerequisites / notice

Session 2: Some methods to study managerial cognition


Session 3: Sensemaking, Mindfulness and Attention


Gavetti, G., D. Levinthal, and W. Ocario. 2007. Neo-Carnegie: The Carnegie School's Past, Present, and Reconstructing for the Future. Organization Science 18:523-36. [Suggested but not required. Daniella will discuss it.] Assignments: At the beginning of each session, students must distribute copies of their critique of the assigned reading (please see your names at the end of each reference). The critique should be brief, extending to a maximum of one printed page. The critique is meant to serve as a starting point for the student to lead the class in a discussion of the strengths and weaknesses of the paper. For each session, students should emphasize the following topics in their critique:

Session 1:
- summarize the research problem or question
- summarize the central framework/ theory that is proposed
- list the strengths of the paper (you can use bulletpoints)
- list the weaknesses of the paper (you can use bulletpoints)

Session 2:
- Same as for session 1 with particular emphasis on the pros and cons of the method used
- Propose at least one alternative methodology and explain why you think the alternative method(s)would have been better suited
- three bullet points summarizing the paper strengths
- three bullet points summarizing the paper weaknesses
- prepare a one-page research idea: what would be a new research question? how would you extend the paper? what could be counterintuitive results?

Please contact Dr Daniella Laureiro Martinez for more information on this course.
Objective

This module aims:
- to provide a basic understanding of key theoretical perspectives on organizational knowledge.
- to provide insights on the research questions, methods, findings and implications of the selected papers.
- to build skills in critically analyzing the literature.
- to identify future research directions.

Content

Given its prominence in the history of organization science, an impressive variety of theories have evolved that deals with organizational epistemology, the way of knowing in the organization (e.g., Brown & Duguid, 1991; Grant, 1996; Kogut & Zander, 1992; Lave & Wenger, 1991; Nonaka, 1994; Spender, 1996; Tsoukas, 1996; von Krogh et al., 1994). In this module, students will learn about various seminal contributions in the area of organizational knowledge and make connections between theory and empirical research, and identify the ongoing trends and future research directions.

Session 1: Knowledge based view of the firm.
Session 2: Knowledge sharing and transfer
Session 3: Social practice view on knowledge and knowing

Literature

Remark: The list might change. Students will be informed about the changes before the first session.

Prerequisites / notice

In each session, students will have three assignments:
1) prepare for in-depth discussion of all papers. The students are supposed to read in advance all the papers that will be presented in the sessions.
2) critically review and discuss the assigned papers. Assignments will be done after participants confirm their presence.
3) submit in advance a short critique of the assigned papers - max 2 pages.

364-1013-01L Organizations and Technical Change

W 1 credit 1G S. Brusoni

Abstract

This 1-credit module is designed to introduce students to selected topics focused on the relationship between technical change and organizational dynamics.

Objective

The objectives of this module are:
1) to provide students with a relatively detailed understanding of some of the major theoretical perspectives and recent developments in organization theory
2) to illustrate how these perspectives have evolved
3) to discuss how they can be operationalized
4) and on these bases develop the ability of constructively criticising them in order to learn how 'to build upon and extend'

Content

Session 1: A Man's got to do ...: Technology rules. Since the 1960s at least, a number of authors have relied on technological lenses to understand organizational design and organizational change. The emergence of complex technologies and production systems (e.g., chemicals, power generation, etc) led many to focus on the pivotal role played by technology in driving (determining?) economic growth and the evolution of firms and industries.

Session 2: Never Mind the Bollocks: Organizations rule. A second stream of research has instead developed the idea that technology is quite malleable to social processes. Technologies do embody individual and collective values and decisions. But it is these values and decisions which drive technological change, not the other way around. There is a wide and broad literature nowadays on social construction, with great impact on both strategy and technology and innovation management, but also Information Systems research and entrepreneurship.

Session 3: It takes two to tango: Technological and organizational dynamics. Last, we shall discuss approaches which aim at reconciling the first two approaches, looking at the dynamic interplay of technological and organizational dynamics.
D. Unger, K. W. Axhausen, G. Grote

In the first class, current understanding of the marketing literature and marketing thought is discussed. The aim is to give to the students the opportunity to review the key results in rational individual behavior, collective models, choice under uncertainty. The purpose of the course is to confront students with current theoretical thinking in marketing, and currently used theories for understanding and explaining buyer and customer behavior in response to marketing action.

It focuses on the theoretical foundations of marketing and marketing research. The objective of the course is to provide students with advanced knowledge in some areas of microeconomic theory. The following topics will be addressed: 1) Individual Behavior. Theory of the consumer (preferences, demand, duality, integrability). Theory of the firm. 2) Collective models. Cooperative and non cooperative models of household behavior. 3) Intertemporal choice. Dynamic model. Life cycle theory.

This course is a mixture between a seminar primarily for PhD and postdoc students and a colloquium involving invited speakers. It consists of presentations and subsequent discussions in the area of modeling complex socio-economic systems and crises. Students and other guests are welcome.

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Text</th>
</tr>
</thead>
</table>
Experimental Methods

C. Waibel

There is no script, but a short protocol of the sessions will be sent to all participants who have participated in a particular session.

Objective

On the one hand, participating students are exposed to research at the frontier of international economic policy research. On the other hand, skills such as critical thinking and preparing reviews are learned.

Literature

Literature will be provided by the speakers in their respective presentations.

Prerequisites / notice

Participants should have relatively good mathematical skills and some experience of how scientific work is performed.

Methods of Inference for Spatial Networks

I. Prucha, P. Egger

Spatial models have been important tools in economics, regional science and geography in analyzing a wide range of empirical issues. The

Abstract

Spatial models have been important tools in economics, regional science and geography in analyzing a wide range of empirical issues. The course will focus, in particular, on Cliff-Ord type spatial models. Those models have the advantage that they only require a measure of distance for modeling interaction between cross sectional units, but do not require for the data to be indexed by location. Since distance is not limited to geographic distance, but could relate to distance in technological space, product space, social distance, etc., those models can be of interest for analyzing a wide range of network generated data. This includes the analysis of peer effects in social networks. The course will discuss generalized methods of moments (GMM) and maximum likelihood (ML) estimation of spatial models from cross-sectional as well as panel data, and will discuss tests for the presence of spatial/network interdependencies.

Literature

Basic Articles:

Course Catalogue of ETH Zurich

Doctoral Department of Management, Technology, and Economics

W+ Eligible for credits and recommended
W Eligible for credits
E- Recommended, not eligible for credits

Z Courses outside the curriculum
Dr Suitable for doctorate
O Compulsory

Key for Hours

V lecture
G lecture with exercise
U exercise
S seminar
K colloquium

P practical/laboratory course
A independent project
D diploma thesis
R revision course / private study

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0530-00L</td>
<td>Thermodynamics</td>
<td>D</td>
<td>0</td>
<td>2K</td>
<td>P. Jenny, R. S. Abhari, K. Boulouchos, P. Koumoutsakos, C. Müller, H. G. Park, D. Poulikakos, H.M. Prasser, T. Rösgen, A. Steinfeld</td>
</tr>
</tbody>
</table>

**Abstract**
Knowledge of advanced research in the areas of thermodynamics and fluid dynamics.

**Objective**
Familiarize students with main architectural principles and concepts of embedded control systems.

<table>
<thead>
<tr>
<th>151-0111-00L</th>
<th>Research Seminar in Fluid Dynamics</th>
<th>E</th>
<th>0</th>
<th>2S</th>
<th>P. Jenny, T. Rösgen</th>
</tr>
</thead>
</table>

**Abstract**
Internal research seminar for graduate students and scientific staffs of the IFD.

**Objective**
Current research projects at the Institute of Fluid Dynamics are presented and discussed.

### Thermo- and Fluid Dynamics

- **Course Code:** 636-0507-00L
- **Title:** Synthetic Biology II
- **ECTS:** 4
- **Hours:** 4A
- **Lecturers:** S. Panke, Y. Benenson, J. Stelling

**Abstract**
7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

**Objective**
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

**Content**
Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

**Lecture notes**
Handouts during course

**Prerequisites / notice**
The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

<table>
<thead>
<tr>
<th>151-0593-00L</th>
<th>Embedded Control Systems</th>
<th>W</th>
<th>4</th>
<th>6G</th>
<th>J. S. Freudenberg, M. Schmid Daners</th>
</tr>
</thead>
</table>

**Abstract**
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

**Objective**
Familiarize students with main architectural principles and concepts of embedded control systems.

**Content**
An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

**Lecture notes**
Lecture notes, lab instructions, supplemental material

**Prerequisites / notice**
Prerequisite courses are Control Systems I and Informatics I.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: schmid@idsc.mavt.ethz.ch)

After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

<table>
<thead>
<tr>
<th>151-0563-01L</th>
<th>Dynamic Programming and Optimal Control</th>
<th>W</th>
<th>4</th>
<th>3G</th>
<th>R. D'Andrea</th>
</tr>
</thead>
</table>

**Abstract**
Introduction to Dynamic Programming and Optimal Control.

**Objective**
Covers the fundamental concepts of Dynamic Programming & Optimal Control.

**Content**
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

**Literature**

**Prerequisites / notice**
Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

<table>
<thead>
<tr>
<th>151-0906-00L</th>
<th>Frontiers in Energy Research</th>
<th>W</th>
<th>2</th>
<th>2S</th>
<th>M. Mazzotti, R. S. Abhari, G. Andersson, J. Carmeliet, M. Filippini</th>
</tr>
</thead>
</table>

**Abstract**
PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.

**Objective**
Knowledge of advanced research in the area of energy.

**Content**
PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.

**Lecture notes**
Slides will be distributed.
Seminar in Fundamentals of Process Engineering

Only for master and doctoral students of Process and Chemical Engineering.

Abstract
This seminar covers actual subjects from the specific research areas of the laboratory of transport processes and reactions.

Objective
Scientific discussion on actual research topics

Content
The contents are announced through the group's webpage.

Lecture notes
No textbook

Leading and Coaching Focus Project Teams (Basic Course)

This course is the first part of a two-semester course.

The course "Leading and Coaching Focus Project Teams (Basic Course)" for Autumn Semester is examined together with the course "Leading and Coaching Focus Project Teams (Advanced Course)" for Spring Semester with 4 ECTS.

Abstract
Aim is enhancement of knowledge and competency regarding coaching skills. Participants should be coaches of focus projects. Topics: Overview of the role and mind set of a coach as, introduction into coaching methodology, building competencies by doing and exchanging good practices from former focus projects.

Objective
Basic knowledge about role and mindset of a coach;
Knowledge and reflection about the classical problems in coaching of a focus project;
Development of personal coaching skills;
Knowledge and know-how about coaching methods;
Reflection and exchange of experiences about personal coaching situations;
Inspiration and learning from good cases regarding organizational and team management aspects.

Content
Content of both basic and advanced course (2 semester):
- Introduction into coaching: definition & models
- Role of coaches between examiner and "friend"
- Knowledge and reflection about the problems in coaching a focus project
- Knowledge about team development
- Reflection about critical phases in the innovation process for an innovation team
- Know-how about reference model for analysis critical situations
- Development of personal coaching competencies, e.g. active listening, asking questions, giving feedback
- Competencies in theoretical models
- Coaching competencies: exercises and reflection
- Knowledge and know-how about coaching methods
- Knowledge about basic coaching methods for technical projects/innovations projects
- Know-how about usage of methods in the coaching process
- Facilitating decisions
- Using and applying coaches opinions and knowledge
- Reflection and exchange of experiences about personal coaching situations
- Self-reflection
- Exchange of experiences in the lecture group
- Good practice on organisational and management aspects
- How to do system and concurrent engineering
- Project planning and replanning
- Facilitating conflict situations
- Discussing sample cases from former teams and actual cases of participants.

Lecture notes
Slides, script and other documents will be distributed via electronically (access only for participants registered to this course).

Literature
Please refer to lecture script.

Prerequisites / notice
Participants (Students, PhD Students, Postdocs) should be part of the coaching team of focus project teams. The course "Leading and Coaching Focus Project Teams (Basic Course)" (HS) is examined together with "Leading and Coaching Focus Project Teams (Advanced Course)" (FS) in FS with 4 ECTS.
Objective

The goal of the lecture is to provide the students with the fundamentals of the non-linear Finite Element Method (FEM). The lecture focuses on the principles of the non-linear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the non-linear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the non-linear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

Content

- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Lecture notes

yes

Literature


Prerequisites / notice

If we will have a large number of students, two dates for the exercises will be offered.

<table>
<thead>
<tr>
<th>Lecture Department of Mechanical and Process Engineering - Key for Type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
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</table>

<table>
<thead>
<tr>
<th>Key for Hours</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Doctoral and Post-Doctoral Courses

### Course Catalogue of ETH Zurich

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0710-00L</td>
<td>Polymer Physics</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. C. Öttinger</td>
</tr>
<tr>
<td></td>
<td>Group seminar in polymer physics</td>
<td></td>
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<tr>
<td></td>
<td>Continued and deeper education in polymer physics, in particular, for Ph.D. students</td>
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<tr>
<td></td>
<td>Presentation and discussion of ongoing research projects by members of the polymer physics group and external speakers</td>
<td></td>
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<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>No script</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Irregular series of presentations (see announcements)</td>
</tr>
<tr>
<td>327-0711-00L</td>
<td>Metal Physics and Technology Seminar</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>J. F. Löfler</td>
</tr>
<tr>
<td></td>
<td>Seminar for Ph.D. students and researchers in the area of metal physics and technology.</td>
<td></td>
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<tr>
<td></td>
<td>Detailed education of researchers in the area of metallic materials.</td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
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<td></td>
<td>Irregular series of presentations (see announcements)</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Prerequisites</td>
<td></td>
<td></td>
<td></td>
<td>Involve in research activities.</td>
</tr>
<tr>
<td></td>
<td>Prerequisites</td>
<td></td>
<td></td>
<td></td>
<td>Lectures are generally in English.</td>
</tr>
<tr>
<td>327-0712-00L</td>
<td>Nanometallurgy</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>R. Spolenak</td>
</tr>
<tr>
<td></td>
<td>Seminar for Ph.D. students and researchers in the area of nanometallurgy.</td>
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<tr>
<td></td>
<td>Detailed education of researchers in the area of nanometallurgy.</td>
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</tr>
<tr>
<td>327-0130-00L</td>
<td>Crystallographic Seminar</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>W. Steurer</td>
</tr>
<tr>
<td></td>
<td>Discussion of interesting scientific topics.</td>
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<tr>
<td></td>
<td>Awareness of topical crystallographic research</td>
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<tr>
<td>327-1300-00L</td>
<td>Joint Group Seminar</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>M. Fiebig, N. Spaldin</td>
</tr>
<tr>
<td></td>
<td>For D-MATL PhD students only</td>
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<tr>
<td></td>
<td>Seminar for PhD students and researchers in condensed-matter physics.</td>
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<tr>
<td></td>
<td>Improving the interaction of researchers in the participating groups.</td>
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<tr>
<td></td>
<td>Presentation and discussion of contemporary research.</td>
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<tr>
<td></td>
<td>Own scientific contributions.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>327-0721-00L</td>
<td>Writing for Publication in Materials Science</td>
<td>Dr</td>
<td>2</td>
<td>1G</td>
<td>S. Milligan</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 15.</td>
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<tr>
<td></td>
<td>Only for D-MATL doctoral students</td>
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<tr>
<td></td>
<td>This short course is designed to help junior researchers in Materials Science develop the skills needed to write their first research articles.</td>
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<tr>
<td></td>
<td>Writing for Publication in Materials Science is a short course (5 x 4-lesson workshops) designed to help junior researchers develop the skills needed to write their first research articles.</td>
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<tr>
<td></td>
<td>The course deals with topics such as</td>
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<tr>
<td></td>
<td>Identifying target readerships and selecting outlets,</td>
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<tr>
<td></td>
<td>Managing the writing process efficiently</td>
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<tr>
<td></td>
<td>Structuring the text effectively</td>
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<tr>
<td></td>
<td>Producing logical flow in sentences and paragraphs</td>
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<tr>
<td></td>
<td>Editing the text before submission, and</td>
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<tr>
<td></td>
<td>Revising the text in response to reviewers' comments.</td>
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<tr>
<td></td>
<td>Participants will be expected to produce a number of short texts as homework assignments and will receive individual feedback on these during the course. Wherever feasible, elements of participants' future research articles can be developed as assignments within the course, so it is likely to be particularly useful for those who have their data and are about to begin the writing process.</td>
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</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Part 1: Introduction to the course; the writing context; identifying target readers and targeting journals; using model texts; activating vocabulary; writing clear English sentences; the English verb system in research publications - using tense, aspect, and voice</td>
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<tr>
<td></td>
<td>Part 2: The writing process; structural decisions (IMRD and variations); from plan to draft; basics of paragraph structure; reader-friendly paragraph structure; patterns and tools for creating logical flow; the English noun phrase in research publications</td>
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<td></td>
<td>Part 3: The experimental narrative; process descriptions, explanation and justification; data commentators; embedding figures, diagrams, etc.</td>
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<td></td>
<td>Part 4: Introductions; creating a research space (CARS); writing about the literature; reference, citation, paraphrase and quotation; discussion and conclusion sections; overview of abstracts and titles</td>
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<td>Part 5: Managing the strength of the claim - hedging and emphasis; punctuation and style; the editing process; responding to reviewers' comments; preparing writing portfolios for assessment and research articles for submission.</td>
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<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>This short course is designed to help junior researchers in Materials Science develop the skills needed to write their first research articles.</td>
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### Doctoral Department of Materials Science - Key for Type

<table>
<thead>
<tr>
<th>W+</th>
<th>Eligible for credits and recommended</th>
<th>Z</th>
<th>Courses outside the curriculum</th>
</tr>
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<tbody>
<tr>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<table>
<thead>
<tr>
<th>Key for Hours</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS | European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
The list of courses (together with the allocated credit points) eligible for doctoral students is published each semester in the newsletter of the ZGSM.

W4: Do not make ECTS credits for credit points for doctoral studies!

### Graduate School

| Number   | Title                                                                 | Type | ECTS | Hours | Lecturers   |
|----------|                                                                      |      |      |       |            |
| 401-5003-65L | The Asymptotic Theory of Transaction Costs | Z    | 0 credits | 2V   | W. Schachermayer |
| Abstract  | Nachdplom lecture                                                   |      |      |       |            |
| Content   | In the traditional no arbitrage theory, which goes back to the seminal work of Black, Scholes, and Merton in the late sixties, one of the idealizing assumptions pertains to the absence of transaction costs. In this classical theory one simply assumes that at any moment of time there is one price for the underlying asset at which one may sell or buy. Since these pioneering papers there is quite some literature on the effects which arise if one deviates from this mathematically convenient but practically sometimes misleading assumption of a frictionless market. In the Nachdplomvorlesung I shall review these results and will put emphasis on the asymptotic effects when proportional transaction costs are small, but different from zero. Special focus will be given to a series of recent papers with Christoph Czichowsky on this theory. In the course we shall also encounter some challenging issues in stochastic analysis arising from the problems arising in the theory of portfolio optimization under small transaction costs. |

| 401-5005-65L | Statistics Meets Optimization: Randomization and Approximation for High-Dimensional Problems | Z    | 0 credits | 2V   | M. Wainwright |
| Abstract  | Nachdplom lecture                                                   |      |      |       |            |
| Content   | In the modern era of high-dimensional data, the interface between mathematical statistics and optimization has become an increasingly vibrant area of research. In this course, we provide some vignettes into this interface, including the following topics: (A) Dimensionality reduction via random projection. The main idea of projecting high-dimensional data to a randomly chosen low-dimensional space is remarkably effective. We discuss the classical Johnson-Lindenstrauss lemma, as well as various modern variants that provide computationally-efficient embeddings with strong guarantees. (B) When is it possible to quickly obtain approximate solutions of large-scale convex programs? In practice, methods based on randomized projection can work very well, and arguments based on convex analysis and concentration of measure provide a rigorous underpinning to these observations. (C) Optimization problems with some form of nonconvexity arise frequently in statistical settings - for instance, in problems with latent variables, combinatorial constraints, or rank constraints. Nonconvex programs are known to be intractable in a complexity-theoretic sense, but the random ensembles arising in statistics are not adversarially constructed. Under what conditions is it possible to make rigorous guarantees about the behavior of simple iterative algorithms for such problems? We develop some general theory for addressing these questions, exploiting tools from both optimization theory and empirical process theory. |

| 401-4589-63L | Calculus of Variations and Conformal Invariance | W    | 6 credits | 3V   | T. Rivière |
| Abstract  | Nachdplom lecture                                                   |      |      |       |            |
| Content   | In this course we will present the classical theory as well as more recent developments of the calculus of variation of surfaces. We will expose method mixing functional analysis and differential geometry in order to produce and describe global and local minimizers or saddle points to two dimensional Lagrangians. In the first part of the class we shall consider the area functional whose critical points are minimal surfaces and study the so-called Plateau problem. Introduced originally by Lagrange in the 18th century. Then we will move to the systematic study of 2-dimensional conformally invariant Lagrangians and explain how they are all related to a generalized Plateau problem of prescribed mean curvature surfaces into submanifolds. In the last part of the class we will present a theory merging minimal surface theory and conformal invariance. This theory has been introduced in the early 20th century by Wilhelm Blaschke and is presently a very active field of research in geometric analysis due in particular to numerous applications in many fields of sciences such as general relativity, elasticity theory, cell biology etc. |
| Prerequisites / notice | Requirements: Fundamental knowledge in functional analysis, Fourier analysis and differential geometry (FAI and DGI) |

| 401-4765-65L | Partial Differential Equations | W    | 7 credits | 4V   | D. Christodoulou |
| Abstract  | Nachdplom lecture                                                   |      |      |       |            |
| Content   | The course covers elliptic partial differential equations in connection to differential geometry and geometric elliptic variational problems. The main topics are the uniformization theorem for 2-dim Riemannian manifolds, harmonic maps from the unit disc to a n-dim Riemannian manifold, and the theory of parametric minimal surfaces in n-dim Euclidean space. |
| Prerequisites / notice | Prerequisites: Real Analysis and Differential Geometry |

| 401-3109-65L | Probabilistic Number Theory | W    | 6 credits | 2V+1U | E. Kowalski |
| Abstract  | Nachdplom lecture                                                   |      |      |       |            |
| Content   | The goal of the course is to present some results of probabilistic number theory, including distribution properties of the number of prime divisors of integers, probabilistic properties of the zeta function and statistical distribution of exponential sums. The main concepts will be presented in parallel with the proof of three main theorems: (1) the Erdös-Kac theorem and its variants concerning the number of prime divisors of integers in various sequences; (2) the distribution of values of the Riemann zeta function, including Selberg's central limit theorem for the Riemann zeta function on the critical line; (3) functional limit theorems for the paths of partial sums of families of exponential sums such as Kloosterman sums. |
| Literature | H. Iwaniec and E. Kowalski: "Analytic number theory", and additional lecture notes will be prepared. |
| Prerequisites / notice | Prerequisites: Complex analysis, measure and integral; some probability theory is useful but the main concepts needed will be recalled. Some knowledge of number theory is useful but the main results will be summarized. |

| 401-3225-60L | Introduction to Lie Groups | W    | 8 credits | 4G   | M. Einsiedler |
| Abstract  | Nachdplom lecture                                                   |      |      |       |            |
| Objective | Topological groups and Haar measure. Definition of Lie groups, examples of local fields and examples of discrete subgroups; basic properties; Lie subgroups. Lie algebras and relation with Lie groups; exponential map, adjoint representation. Semisimplicity, nilpotency, solvability, compactness: Killing form, Lie's and Engel's theorems. Definition of algebraic groups and relation with Lie groups. |

### Literature

- A. Knapp: "Lie groups beyond an Introduction" (Birkhaeuser)
- A.Sagle & R. Walde: "Introduction to Lie groups and Lie algebras" (Academic Press, '73)
- F.Warner: "Foundations of differentiable manifolds and Lie groups" (Springer)
- H. Samelson: "Notes on Lie algebras" (Springer, '90)
- S. Helgason: "Differential geometry, Lie groups and symmetric spaces" (Academic Press, '78)

### Prerequisites / notice

Topology and basic notions of measure theory. A basic understanding of the concepts of manifold, tangent space and vector field is useful, but could also be achieved throughout the semester.


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### 401-3001-61L Algebraic Topology I

**W 8 credits 4G**

**P. Biran**

**Abstract**

This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory, homology and cohomology of spaces.

**Literature**


Book can be downloaded for free at: [http://www.math.cornell.edu/~hatcher/AT/ATpage.html](http://www.math.cornell.edu/~hatcher/AT/ATpage.html)

See also: [http://www.math.cornell.edu/~hatcher/#anchor1772800](http://www.math.cornell.edu/~hatcher/#anchor1772800)

3) E. Spanier, "Algebraic topology", Springer-Verlag

**Prerequisites / notice**

Some knowledge of differential geometry and differential topology is useful but not absolutely necessary.

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### 401-4149-65L Reading Course: Geometric Invariant Theory

**W 2 credits 4A**

**J. Fresán, P. S. Jossen**

**Objective**

The goal of this reading course is to give an introduction to GIT, with emphasis on examples rather than the most general statements.

After a couple of introductory sessions, participants will contribute with talks.

**Content**

- existence of affine and projective quotients
- the Hilbert-Mumford criterion
- construction of the moduli space of elliptic curves
- semistable vector bundles on curves

**Literature**


**Prerequisites / notice**

Basic knowledge of algebraic geometry will be assumed.

---

### 401-3523-65L Equidecomposability of Polytopes

**W 4 credits 2V**

**L. Parapatits**

**Abstract**

A polygon in the plane can be decomposed into finitely many (convex) pieces and reassembled to form another polygon if and only if they have the same area. Hilbert's third problem asks if the analogous is also true for two polyhedra in space. Whether or not it is possible to define volume without the use of approximation arguments depends on the answer to this question.

**Objective**

We will cover topics as:

- existence of affine and projective quotients
- the Hilbert-Mumford criterion
- construction of the moduli space of elliptic curves
- semistable vector bundles on curves

**Prerequisites / notice**

Office hours: Thursday 11:00 - 12:00

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### 401-4657-00L Numerical Analysis of Stochastic Ordinary Differential Equations

**W 6 credits 3V+1U**

**A. Jentzen**

**Abstract**

Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

**Objective**

The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

**Content**

- Generation of random numbers
- Monte Carlo methods for the numerical integration of random variables
- Stochastic processes and Brownian motion
- Stochastic ordinary differential equations (SODEs)
- Numerical approximations of SODEs
- Multilevel Monte Carlo methods for SODEs
- Applications to computational finance: Option valuation

**Lecture notes**

Lecture Notes will be available.
**Abstract**
This course gives a comprehensive introduction into the numerical treatment of linear and non-linear elliptic boundary value problems, related eigenvalue problems and linear, parabolic evolution problems. Emphasis is on theory and the foundations of numerical methods. Practical exercises include MATLAB implementations of finite element methods.

**Objective**
Participants of the course should become familiar with

- concepts underlying the discretization of elliptic and parabolic boundary value problems
- analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems
- methods for the efficient solution of discrete boundary value problems
- implementational aspects of the finite element method

A selection of the following topics will be covered:

- Elliptic boundary value problems
- Galerkin discretization of linear variational problems
- The primal finite element method
- Mixed finite element methods
- Discontinuous Galerkin Methods
- Boundary element methods
- Spectral methods
- Adaptive finite element schemes
- Singularly perturbed problems
- Sparse grids
- Galerkin discretization of elliptic eigenproblems
- Non-linear elliptic boundary value problems
- Discretization of parabolic initial boundary value problems

**Lecture notes**
Course slides will be made available to the audience.

**Prerequisites / notice**
Practical exercises based on MATLAB
Content

1. Infinite-Dimensional Analysis
   - Probability spaces and measures,
   - Tensor Products,
   - Measures on function spaces,
   - Covariance operators,
   - PCA and KL-expansions,
   - (generalized) polynomial chaos expansions,
   - Kolmogoroff N-widths

2. Examples.
   - Parametric Approximation Problems.
   - Parametric ODEs (biochemical reaction pathways).
   - Parametric PDEs (diffusion problems with random coefficients).
   - PDEs in Parametric Domains (Scattering from random obstacles).


4. Stochastic Galerkin Methods

5. Stochastic Collocation Methods
   - Smolyak’s algorithm and its generalizations;
   - sparse, adaptive interpolation algorithms

6. Reduced Basis Methods

7. Monte Carlo Methods

8. Quasi-Monte Carlo Methods

   - Bayesian Inverse Problems
   - Shape Sensitivity Analysis of PDEs,
   - Optimal Control of parametric ODEs and PDEs.
   - Optimization of Parametric ODEs and PDEs.

Literature


2. F. Y. Kuo and Ch. Schwab and I. H. Sloan


4. Ch. Schwab and C. J. Gittelson

Prerequisites / notice

ETH BSc Math or equivalent

and

Num. elliptic and Parabolic PDE
or
Num. hyperbolic PDE
or

ETH Doctoral Studies in applied mathematics or CSE.

Programming:

MATLAB (for MSc MATH)
or
Python and C/C++/MPI programming (MSc CSE).

401-4607-59L Percolation Theory W 4 credits 2V P. Nolin

Abstract

An introduction to the percolation theory.

Objective

The objective is to gain familiarity with the methods of the percolation theory and to learn some of its important results.

Content

Definition of percolation, FKG and BK inequalities, Harris-Kesten Theorem, Menshikov’s Theorem, uniqueness of the infinite cluster and possibly Smirnov’s Theorem on the conformal invariance of the critical percolation.

Literature

B. Bollobas, O. Riordan: Percolation, CUP 2006

Prerequisites / notice

401-2604-00L Probability and Statistics (mandatory)
401-3601-00L Probability Theory (recommended)

401-3611-00L Advanced Topics in Computational Statistics W 4 credits 2V M. H. Maathuis, M. Mächler

Abstract

This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.
### High-Dimensional Statistics

**Objective**

Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

**Content**

The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

**Lecture notes**

Lecture notes.

**Prerequisites / notice**

We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

**401-3833-65L**  
**Chaotically Singular Spacetimes**  
**W** 6 credits  
**3V** not available

**Abstract**

Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

**Objective**

This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations.

**Content**

Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

**Lecture notes**

A list of references will be distributed during the course.

**Literature**

Not available

**Prerequisites / notice**

Basic knowledge in probability and statistics.

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**401-3627-00L**  
**High-Dimensional Statistics**  
**W** 4 credits  
**2V**

**P. L. Bühlmann**

**Objective**

Knowledge of methods and basic theory for high-dimensional statistical inference.

**Content**

Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling.

**Literature**


**Prerequisites / notice**

Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

---

**401-4623-00L**  
**Time Series Analysis**  
**W** 6 credits  
**3G** not available

**Abstract**

Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

**Objective**

Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

**Content**

This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations.

**Literature**


**Prerequisites / notice**

Basic knowledge in probability and statistics.
Basics of phenomenological thermodynamics, three laws of thermodynamics.
Classical statistical physics: microcanonical ensembles, canonical ensembles and grandcanonical ensembles, applications to simple systems.
Quantum statistical physics: single particle, ideal quantum gases, fermions and bosons.
Bose-Einstein condensation: Bogolyubov theory, superfluidity.
Critical phenomena: mean field, series expansions, scaling behavior, universality.
Renormalization group: fixed points, simple models.
Linear response theory; general formulation, response in mean field, sum rules, collective modes, fluctuation dissipation theorem.

Combining, Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsie's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.

Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

This course is an introduction to the equilibrium models prevalent in Financial Economics. We will start by studying optimisation on numerical implementation and calibration.

Prerequisites: probability theory and stochastic processes (for which lecture notes are available).


2) Learn about the technical tools.
1) Understand the conceptual ideas.
2) Learn about the technical tools.
3) Gain an overview over the problems that can be studied and solutions that can be obtained using equilibrium models.

This course provides an introduction to the equilibrium models prevalent in Financial Economics. We will start by studying optimisation problems for individual investors, and then move towards equilibrium prices, determined so that supply matches demand. The initial focus will be on conceptual issues in simple one-period models, before moving to more general settings in continuous time.

Equilibrium Models in Financial Economics

-Learn about extensions that have recently become increasingly important: default risk, multiple yield curves, etc.
-Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
-Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.

Brownian Motion and Stochastic Calculus, Introduction to Mathematical Finance or Mathematical Foundations for Finance

The course also includes numerical methods like Markov chain approximations, Galerkin approximations, and particle filtering, as well as applications to financial models of, e.g., interest rates or credit risk.

The course starts with linear (Kalman) filtering and progresses to non-linear filtering for semimartingale state and observation processes. Filtering is the task of recovering unobserved state variables from noisy observations. This course covers the theoretical foundations of filtering in various levels of generality, as well as numerics and applications in statistics and finance.

Prerequisites: probability theory, basic stochastic processes, basic statistics.

The former (spring semester 2013) course title of the course unit 401-4926-13L was Filter Theory -- Theory and Applications.

-Additional topics
-Option pricing and hedging
-Absence of arbitrage and martingale measures

Stochastic Filtering - Theory and Applications


The course also includes numerical methods like Markov chain approximations, Galerkin approximations, and particle filtering, as well as applications to financial models of, e.g., interest rates or credit risk.

Prerequisites: probability theory, basic stochastic processes, basic statistics.

Note: The former (spring semester 2013) course title of the course unit 401-4926-13L was Filter Theory -- Theory and Applications.

Interest Rate Theory

-We introduce and discuss the most important models for interest rate markets. Emphasis will be placed both on theoretical foundations and on numerical implementation and calibration.
-Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.
-Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.

-Additional topics
-Option pricing and hedging
-Absence of arbitrage and martingale measures

Error in table:

<table>
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<tr>
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<td>Stochastic Filtering - Theory and Applications</td>
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<td>401-3059-00L</td>
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<td>12</td>
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<tr>
<td>401-4935-63L</td>
<td>Equilibrium Models in Financial Economics</td>
<td>4</td>
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<tr>
<td>401-4936-61L</td>
<td>Brownian Motion and Stochastic Calculus</td>
<td>6</td>
<td>2+1U</td>
<td>P. Harms</td>
<td></td>
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</table>

401-3953-00L Interest Rate Modeling in Discrete Time

Abstract
This course gives an introduction to stochastic interest rate modeling in discrete time. Starting from cash flow valuation with state price deflators, we derive the equivalent martingale measures for pricing financial instruments and derivatives of primary assets. The lecture is supplemented by several examples such as the Vasicek model where we also study model calibration.

Objective
The students are familiar with the basic terminology of stochastic interest rate modeling and he is able to transfer his (financial) mathematical knowledge to real world pricing of cash flows and financial instruments.

Content
The following topics are covered:
1) stochastic discounting with state price deflators
2) equivalent martingale measures
3) pricing of cash flows and primary assets
4) pricing of derivatives, e.g. European put options
5) (multi-factor) Vasicek state price deflator model
6) Heath-Jarrow-Morton interest rate modeling framework

Lecture notes
Part I of:

Literature
For further reading:

Prerequisites / notice
The exams ONLY take place during the official ETH examination period.

Prerequisites:
- Option pricing and hedging for equity markets as covered, e.g., in "Mathematical Foundations for Finance".
- Itô calculus.

Seminars

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>401-4600-65L</td>
<td>Student Seminar in Probability: Gaussian Processes</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>A.S. Sznitman, J. Bertoin, A. Knowles, P. Nolin, W. Werner</td>
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<td>Limited number of participants.</td>
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<tr>
<td></td>
<td>Registration to the seminar will only be effective once confirmed by email from the organizers.</td>
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Abstract
The seminar will discuss results concerning branching Brownian motion.

Content
The seminar is centered around a topic in probability theory which changes each semester.

Prerequisites / notice
The student seminar in probability is held at times at the undergraduate level (typically during the spring term) and at times at the graduate level (typically during the autumn term). The themes vary each semester.

The number of participants to the seminar is limited. Registration to the seminar will only be effective once confirmed by email from the organizers.

Colloquia

<table>
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<tr>
<th>Number</th>
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<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
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</table>

Abstract
The Graduate Colloquium is an informal seminar aimed at graduate students and postdocs whose purpose is to provide a forum for communicating one's interests and thoughts in mathematics.

<table>
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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>401-5110-00L</td>
<td>Number Theory Seminar</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>Ö. Imamoglu, P. S. Jossen, E. Kowalski, P. D. Nelson, R. Pink</td>
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</table>

Abstract
Research colloquium

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>401-5140-11L</td>
<td>Algebraic Geometry and Moduli Seminar</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>R. Pandharipande</td>
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</table>

Abstract
Research colloquium

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<td>E-</td>
<td>0</td>
<td>1K</td>
<td>M. Burger, M. Einsiedler, A. Iozzi, U. Lang, V. Schroeder, A. Sisto</td>
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</table>

Abstract
Research colloquium

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-5350-00L</td>
<td>Analysis Seminar</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>M. Struve, D. Christodoulou, F. Da Lio, N. Hungerbühler, T. Kappeler, T. Rivière, D. A. Satamon</td>
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Abstract
Research colloquium

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<th>Hours</th>
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<tbody>
<tr>
<td>401-5580-00L</td>
<td>Symplectic Geometry Seminar</td>
<td>E-</td>
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<td>2K</td>
<td>D. A. Salamon, P. Biran, A. Cannas da Silva</td>
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Abstract
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<tr>
<td>401-5330-00L</td>
<td>Talks in Mathematical Physics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, H. Knörer, T. H. Willwacher, University lecturers</td>
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Abstract
Research colloquium

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<th>Hours</th>
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<tr>
<td>401-5600-00L</td>
<td>Seminar on Stochastic Processes</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>J. Bertoin, A. Knowles,</td>
</tr>
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</table>
### Research Seminar on Statistics

**401-5620-00L**

**Abstract**
Research colloquium

**Content**
Research colloquium

**Objective**
Talks in Financial and Insurance Mathematics

**Content**
Regular research talks on various topics in mathematical finance and actuarial mathematics

**Abstract**
Talks in Financial and Insurance Mathematics

**Content**
E- 0 credits 2K

---

**Talks in Financial and Insurance Mathematics**

**401-5910-00L**

**Abstract**
Research colloquium

**Content**
Research colloquium

**Objective**
Talks in Financial and Insurance Mathematics

**Content**
E- 0 credits 1K

---

**Optimization Seminar**

**401-5900-00L**

**Abstract**
Lectures on current topics in optimization

**Content**
Lectures on current topics in optimization

**Objective**
Expose graduate students to ongoing research activities (including applications) in the domain of optimization.

**Content**
This seminar is a forum for researchers interested in optimization theory and its applications. Speakers are expected to stimulate discussions on theoretical and applied aspects of optimization and related subjects. The focus is on efficient algorithms for continuous and discrete optimization problems, complexity analysis of algorithms and associated decision problems, approximation algorithms, mathematical modeling and solution procedures for real-world optimization problems in science, engineering, industries, public sectors etc.

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**Doctoral Department of Mathematics - Key for Type**

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<th>Description</th>
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<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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**Key for Hours**

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<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>practical/laboratory course</td>
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<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

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**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
2V+1U

### Doctoral and Post-Doctoral Courses

Please note that this is an INCOMPLETE list of courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0317-00L</td>
<td>Semiconductor Materials: Fundamentals and Fabrication</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>S. Schön. W. Wegscheider</td>
</tr>
</tbody>
</table>

**Abstract**
This course gives an introduction into the fundamentals of semiconductor materials. The main focus is on state-of-the-art fabrication and characterization methods. The course will be continued in the spring term with a focus on applications.

**Objective**
Basic knowledge of semiconductor physics and technology. Application of this knowledge for state-of-the-art semiconductor device processing.

**Content**
Fundamentals of Solid State Physics: Semiconductor materials, band structures, carrier statistics in intrinsic and doped semiconductors, p-n junctions, low-dimensional structures;
Bulk Material growth of Semiconductors: Czochralski method, floating zone method, high pressure synthesis;
Semiconductor Epitaxy: Fundamentals, MBE, MOCVD, LPE;
In situ characterization: RHEED, LEED, AES, XPS, process control (temperature, thickness)

**Lecture notes**
https://moodle-app2.let.ethz.ch/course/view.php?id=1044

| 402-0526-00L | Ultrafast Processes in Solids                   | W    | 6 credits | 2V+1U | Y. M. Acremann, A. Vaterlaus |

**Abstract**
Ultrafast processes in solids are of fundamental interest as well as relevant for modern technological applications. The dynamics of the lattice, the electron gas as well as the spin system of a solid are discussed. The focus is on time resolved experiments which provide insight into pico- and femtosecond dynamics.

**Objective**
After attending this course you understand the dynamics of essential excitation processes which occur in solids and you have an overview over state of the art experimental techniques used to study fast processes.

**Content**
1. Experimental techniques, an overview
2. Dynamics of the electron gas
   2.1 First experiments on electron dynamics and lattice heating
   2.2 The finite lifetime of excited states
   2.3 Detection of lifetime effects
   2.4 Dynamical properties of reactions and adsorbents
3. Dynamics of the lattice
   3.1 Phonons
   3.2 Non-thermal melting
4. Dynamics of the spin system
   4.1 Laser induced ultrafast demagnetization
   4.2 Ultrafast spin currents generated by lasers
   4.3 Landau-Lifschitz-Dynamics
   4.4 Laser induced switching
5. Correlated materials

**Lecture notes**
will be distributed

**Literature**
relevant publications will be cited

**Prerequisites / notice**
The lecture can also be followed by interested non-physics students as basic concepts will be introduced.

This lecture is complementary to the lecture on "ultrafast methods for solid state physics" of the spring semester. Both lectures can be attended independently. The focus of this lecture is on the physical processes whereas the focus of the "ultrafast methods for solid state physics" lecture is on the experimental techniques.

| 402-0402-00L | Ultrafast Laser Physics                         | W    | 6 credits | 2V+1U | L. P. Gallmann |

**Abstract**
Ultrasound pulse generation, few-cycle pulses, frequency combs, ultrafast measurement techniques

**Objective**
This lecture will introduce students to active ongoing research topics and provide their fundamental background.

**Content**
Dispersion and dispersion compensation, linear and nonlinear pulse propagation, relaxation oscillations, Q-switching, modelocking, pulse diagnostics, pulse generation in the few-optical-cycle regime (i.e. around 5 fs in the near infrared wavelength regime), carrier-envelope offset control and frequency combs, ultrafast measurement techniques (pump-probe measurements, time-resolved four-wave mixing, THz-Spectroscopy, optical coherence tomography), hot topics such as attosecond pulse generation and supercontinuum generation.

**Lecture notes**
Class notes will be available.

**Prerequisites / notice**
Prerequisites: Basic knowledge of quantum electronics (e.g., 402-0275-00L Quantenelektronik).

| 402-0415-62L | Terahertz Technology and Applications           | W    | 6 credits | 2V+1U | S. Johnson |

**Abstract**
This course gives a practical overview over the generation of THz frequency electromagnetic radiation and over the applications of this radiation in a variety of fields, both scientific and industrial.

**Objective**
Terahertz frequency electromagnetic radiation lies at the border between electronics and optics, and as such has many unique properties that make it well-suited to study the electronic, magnetic and structural properties of many materials. The course objective is to give students the ability to identify problems that can be addressed using terahertz frequency radiation and to design (on a conceptual level) a way to implement solutions to these problems. These "problems" include both scientific (in physics, chemistry and biology) and industrial (medicine, pharmaceuticals, security) areas.

On the scientific side the applications of THz relate to understanding the electronic, structural and magnetic properties of materials by studying the optical response at low frequencies without the need for physical contact with the sample. The industrial applications tend to be more related imaging (e.g. THz-based airport scanners), but also some spectroscopy is done to identify materials.

**Content**
Topics to be discussed in the class include:
1) Overview of THz & interactions with matter
2) THz generation methods
3) THz optics and electronics
4) THz detection methods
5) THz applications
   - a) Spectroscopy
   - b) Imaging
Although many lectures will follow the course texts, significant deviations will be distributed as a script. The readings for the course will be selected from several different texts. All of these are available electronically via the ETH library system. You can also order a black-and-white paperback via an "on-demand" system for a pretty reasonable price.

Principles of Terahertz Science and Technology, Yun-Shick Lee (Springer, 2008). More of a focus on basic principles, many of the readings will come from this book.

Introduction to THz Wave Photonics, Xi-Cheng Zhang and Jingzhou Xu (Springer, 2010). Fairly good overview, also good description of applications.


- Spin Physics in the time Domain

These three Chapters will be given by A. Vindigni and are an essential introduction to more specialized Topics given in selected lectures, such as the one by R. Allenspach in FS16.

The course is taught in English.

recommended. Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program.

The former title of this course unit was “Fundamental Aspects of Magnetism”. This lecture insists on the fundamental aspects -- Quantum physics and statistical physics of magnetism. Applications to nanoscale magnetism will be discussed within this fundamental Approach.

The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.

At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:
1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots

1. Introduction and overview
2. Semiconductor crystals: Fabrication and band structures
3. k.p-theory, effective mass
4. Envelope functions and effective mass approximation, heterostructures and band engineering
5. Fabrication of semiconductor nanostructures
6. Elektrostatics and quantum mechanics of semiconductor nanostructures
7. Heterostructures and two-dimensional electron gases
8. Drude Transport
9. Electron transport in quantum point contacts; Landauer-Büttiker description
10. Ballistic transport experiments
11. Interference effects in Aharonov-Bohm rings
12. Electron in a magnetic field, Shubnikov-de Haas effect
13. Integer quantum Hall effect
14. Coulomb blockade and quantum dots


In addition to the lecture notes, the following supplementary books can be recommended:

The lecture is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program. The course is taught in English.

The rich physics of the optical properties of semiconductors, as well as the advanced processing available on these material, enabled numerous applications (lasers, LEDs and solar cells) as well as the realization of new physical concepts. Systems that will be covered include quantum dots, exciton-polaritons, quantum Hall fluids and graphene-like materials.

This course gives a survey of current research topics using accelerator-based probes (photons, neutrons, muons) to study problems in condensed matter and biophysics.

The course aims to give students the ability to follow and explain on a conceptual level the ways in which accelerator-based facilities (photon, neutron and muon sources) enable the study of various problems in a wide range of fields, including for example quantum information theory, solid state dynamics in superconductors and low dimensional systems, quantum phase transitions, as well as structural biology.

The course will discuss several current examples of research using accelerator facilities highlighting different technologies and their applications. Specific attention will be given to x-ray spectroscopy and scattering experiments conducted at synchrotrons and x-ray Free Electron Lasers, as well as neutron scattering experiments at spallation sources and muon spin rotation.

Prerequisites:
Solid State Physics, Quantum Mechanics

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Type</th>
<th>Credits</th>
<th>Prerequisites</th>
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<tbody>
<tr>
<td>402-0715-00L</td>
<td>Low Energy Particle Physics</td>
<td>W</td>
<td>6</td>
<td>A. S. Antognini, F. Piegna</td>
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<th>Prerequisites</th>
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<tr>
<td>402-0767-00L</td>
<td>Neutrino Physics</td>
<td>W</td>
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<td>A. Rubbia</td>
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<th>Prerequisites</th>
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<tr>
<td>402-0898-00L</td>
<td>The Physics of Electroweak Symmetry Breaking</td>
<td>W</td>
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<tbody>
<tr>
<td>402-0899-65L</td>
<td>Higgs Physics</td>
<td>W</td>
<td>6</td>
<td>M. Donegà, M. Grazzini</td>
</tr>
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</table>

Literature
Golub, Richardson & Lamoreaux: "Ultra-Cold Neutrons"
Rauch & Werner: "Neutron Interferometry"
Carlile & Willis: "Experimental Neutron Scattering"
Byrne: "Neutrons, Nuclei and Matter"
Klapdor-Kleingrothaus: "Non Accelerator Particle Physics"

Prerequisites:
Solid State Physics, Quantum Mechanics

Einführung in die Kern- und Teilchenphysik / Introduction to Nuclear- and Particle-Physics

Neutrino Physics

The course will discuss several current examples of research using accelerator facilities highlighting different technologies and their applications. Specific attention will be given to x-ray spectroscopy and scattering experiments conducted at synchrotrons and x-ray Free Electron Lasers, as well as neutron scattering experiments at spallation sources and muon spin rotation.

The course gives an introduction to selected advanced topics in low energy particle physics with neutrons and muons.

Low energy particle physics provides complementary information to high energy physics with colliders. In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today.

In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Starting from a general introduction on high intensity/high precision particle physics and the main characteristics of muons and neutrons and their production, we will then focus on the discussion of fundamental problems and ground-breaking experiments:

- Production and characteristics of muon and neutron beams
- Ultracold neutron production
- Measurement of the neutron lifetime and electric dipole moment
- The neutron in the gravitational field and its electric charge
- Muon and neutron decay correlations
- Lepton flavour violations with muons to search for new physics
- What atomic physics can do for particle physics and vice versa
- Laser experiments at accelerators
- From myonic hydrogen to the proton structure and bound-state QED
- From pionic hydrogen to the strong interaction and effective field theories
- etc.

The former title of this course was "The Physics Beyond the Standard Model". If you already got credits for "The Physics Beyond the Standard Model" (402-0898-00L), you cannot get credits for "The Physics of Electroweak Symmetry Breaking" (402-0899-65L).

The course aims to give students the ability to follow and explain on a conceptual level the ways in which accelerator-based facilities (photon, neutron and muon sources) enable the study of various problems in a wide range of fields, including for example quantum information theory, solid state dynamics in superconductors and low dimensional systems, quantum phase transitions, as well as structural biology.

The course will discuss several current examples of research using accelerator facilities highlighting different technologies and their applications. Specific attention will be given to x-ray spectroscopy and scattering experiments conducted at synchrotrons and x-ray Free Electron Lasers, as well as neutron scattering experiments at spallation sources and muon spin rotation.

The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experiments.
With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

- the Standard Model and the mass problem: WW scattering and the no-lose theorem
- the Higgs mechanism and its implementation in the Standard Model
- radiative corrections and the screening theorem
- theoretical constraints on the Higgs mass; the hierarchy problem
- Higgs production in e+e- collisions
- Higgs production at hadron colliders
- Higgs decays to fermions and vector bosons
- Higgs differential distributions, rapidity distribution, pt spectrum and jet vetoes
- Higgs properties and beyond the Standard Model perspective
- Outlook: The Higgs sector in weakly coupled and strongly coupled new physics scenarios.

The theme we want to discuss this year is: what do we know about the assembly of diffuse baryons into galaxies and stars, from the physics that govern the birth of new stars, out to the dark matter halos onto which baryons are accreted on cosmological timescales. Specifically, we will focus on the following two -- or, time-permitting, three -- Hot Topics in Astrophysics.

- Hot Topics in Astrophysics
- Observational Techniques in Astrophysics

The course introduces analysis techniques, the basics of astronomical instruments, real-world observational tools, data reduction strategy and software packages used in astrophysics research. The course will also include discussions of current topics in astrophysics with a focus on active galaxies. The course will include the reduction and analysis of real data from a variety of observatories.

The goal is to acquaint students with the basics of a range of astrophysical observation techniques including the modern software tools needed to analyze data.

- Statistical methods play a vital role in modern cosmology and astrophysics studies. This course will give an overview of the statistical principles and tools that are used in these fields. Topics covered will include basic probability theory, Bayesian inference, hypothesis testing, sampling and estimators.

- Develop an understanding of basic probability and statistical theory. Gain practical knowledge of statistical methods commonly used in cosmology and astrophysics.

- Credit or current enrollment in Astrophysics I is recommended but not required.

The course gives an introduction to the development and anatomical structure of nervous systems. Furthermore, it discusses the basics of cellular neurophysiology and neuropharmacology. Finally, the nervous system is described on a system level with a particular emphasis on the visual system.
Content
1) Neuroanatomy I
2) Neuroanatomy II
3) Neurogenesis
4) Axon guidance
5) Action and language development
6) Circadian rhythms
7) Synaptic plasticity
8) Synaptic transmission
9) Neural circuits in vivo
10) Visual pathways and visual processing
11) Somatosensory system
12) Vestibular system
13) Sleep
14) Learning and Memory, mice and human

Prerequisites / notice
For doctoral students of the Neuroscience Center Zurich (ZNZ).

<table>
<thead>
<tr>
<th>Code</th>
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<tbody>
<tr>
<td>402-0620-00L</td>
<td>Current Topics in Accelerator Mass Spectrometry and Their Applications</td>
<td>E-</td>
<td>0</td>
<td>M. Christl, S. Willett</td>
</tr>
</tbody>
</table>

Abstract
The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

Objective
This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.

Prerequisites / notice

Doctoral Department of Physics - Key for Type

<table>
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<tr>
<th>Type</th>
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Key for Hours

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ECTS European Credit Transfer and Accumulation System

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### Agricultural Science

#### Graduate Programme in Plant Sciences

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<tr>
<td>760-2211-00L</td>
<td>Colloquium Agricultural Science</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>E. Frossard, N. Buchmann, W. Gruissem, M. Kreuzer, O. Voinnet, A. Walter, S. C. Zeeman</td>
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#### Environmental Sciences

#### Atmosphere and Climate

<table>
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<td>402-0572-00L</td>
<td>Aerosols I: Physical and Chemical Principles</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>M. Gysel, U. Baltensperger, H. Burtscher</td>
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<td>701-1253-00L</td>
<td>Analysis of Climate and Weather Data</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Frei</td>
</tr>
</tbody>
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**Objective**

- Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

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**Content**

- Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

---

**Literature**

Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology.

Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

The lecture also provides an introduction into R, a programming language and graphics tool frequently used for data analysis in meteorology and climatology. During hands-on computer exercises the student will become familiar with the practical application of the methods.

Lecture notes

Documentation and supporting material include:
- documented view graphs used during the lecture
- exercise sets and solutions
- R-packages with software and example datasets for exercise sessions

All material is made available via the lecture web-page.

Literature

Suggested literature:

Prerequisites / notice

Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahes Programmieren.

701-1235-00L  Cloud Microphysics  W  4 credits  2V+1U  U. Lohmann, B. Sierau

Abstract
Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth’s radiation balance. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes. In this course the sought-after topic of ice formation in clouds is studied from a theoretical and empirical perspective.

Objective
Students will gain an appreciation and understanding of the complex processes in clouds and the necessary physical phenomenon that are involved and need to be accounted for in order to study cloud and precipitation formation.

Content
Microstructure of clouds and precipitation, aerosol activation to form cloud droplets, ice crystal nucleation (homogeneous freezing of supercooled aerosol and heterogeneous freezing), precipitation formation

Lecture notes
Powerpoint slides will be made available

Literature

Prerequisites / notice
At least one introductory course in Atmospheric Science or Instructor's consent.

701-1221-00L  Dynamics of Large-Scale Atmospheric Flow  W  4 credits  2V+1U  H. Wernli, S. Pfahl

Abstract
Dynamic, synoptic Meteorology

Objective
Understanding the dynamics of large-scale atmospheric flow

Content
Dynamical Meteorology is concerned with the dynamical processes of the earth’s atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Powerpoint slides will be made available

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

701-1251-00L  Land-Climate Interactions  W  3 credits  2G  S. I. Seneviratne, E. L. Davin

Abstract
The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

Objective
The students can understand the role of land processes and associated feedbacks for the climate system.

Lecture notes
Powerpoint slides will be made available

Prerequisites / notice
Prerequisites: Introductory lectures in atmospheric and climate science

701-1237-00L  Solar Ultraviolet Radiation  W  1 credit  1V  J. Gröbner

Abstract
The lecture will introduce the student to the thematics of solar ultraviolet radiation and its effects on the atmosphere and the biosphere. The lecture will cover the modeling and the measurement of solar ultraviolet radiation. The instruments used for solar radiation measurements will also be introduced.

Objective
The lecture should enable the student to understand the specific problematics related to solar ultraviolet radiation and its interaction with the atmosphere and the biosphere.
1) Einführung in die Problematik Motivation
Begriffe (UV-C, UV-B, UV-A,...)
Einfluss der UV Strahlung auf Biosphäre (Mensch, Tier, Pflanzen)
Positive und schädliche Effekte
Wirkungsspektrum, Konzept, Beispiele
UVIndex.

2) Geschichtlicher Rückblick
Rayleigh - Himmelsblau
1907: Dorno, PMOD
1970: Bener, PMOD
1980: Berger, Erythemal sunburn meter
1990-: State of the Art

3) Extraterrestrische UV Strahlung
Spektrum
Energieverteilung
Variabilität (Spektral, zeitlich, relativ zu Totalstrahlung)
Satellitenmessungen, Übersicht

4) Einfluss der Atmosphäre auf die solare UV Strahlung
Atmosphärenaufbau
Beinflussende Parameter (Ozon, Wolken, ...)
Ozon, Stratosphärisches versus troposphärisches
Geschichte: Ozondepletion, Poleare Ozonlöcher und Einfluss auf die UV Strahlung
Wolken
Aerosole
Rayleighstreuung
Trends (Ozon, Wolken, Aerosole)
Radiation Amplification Factor (RAF)

5-6) Strahlungstransfer
Strahlungstransfersgleichung
Modellierung, DISORT
LibRadtran, TUV, FASTRT
Parameter
Sensitivitätsstudien
Vergleiche mit Messungen
3-D Modellierung (MYSTIC)
Beer-Lambert Gesetz

7) Strahlungsmessungen
Instrumente zur Strahlungsmessung
Messgrössen: Irradiance (global, direct, diffus), radiance, aktinischer Fluss
Horizontale und geneigte Flächen
Generelle Problematik: Freiluftmessungen...
Qualitätssicherung

8) Solare UV Strahlungsmessungen
Problematic: Dynamik, Spektrale Variabilität, Alterung
Stabilität
Spezifische Instrumente: Filterradiometer, Spektroradiometer, Dosimetrie
Übersicht Aufbau und Verwendung

9-10) Solare UV Strahlungsmessgeräte
Spektroradiometer, Filterradiometer (Breit und schmalbandig)
Charakterisierung
Kalibriermethoden (Im Labor, im Feld)
Qualitätssicherung, Messkampagnen

11-12) Auswerteverfahren
Atmosphärische Parameter aus Strahlungsmessungen
Ozon, SO2
Albedo (Effektiv versus Lokal)
Aerosol Parameter (AOD, SSA, g, Teilchenverteilungen)
Zusammenspiel Messungen - Modellierung
Aktinische UV-Strahlungsflüsse und Bestimmung von atmosphärischen Photolysefrequenzen

13) UV Klimatologie
Trends
UV Klimatologie durch Messnetze
UV Klimatologie durch Satellitenmessungen am Beispiel von TOMS
Modellierung am Beispiel Meteosat-JRC
UV Rekonstruktionen

14) Aktuelle Forschungen
Internationale Projekte, Stand der Forschung

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**Abstract**

**Objective**
The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.
Isotopic and Organic Tracers in Biogeochemistry

The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved chemical processes, their limitations, and methodologies. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential applications in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course "Isotopic and Organic Tracers Laboratory".

Prerequisites / notice

Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.

701-1211-01L Master's Seminar: Atmosphere and Climate 1

Abstract

In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.

Objective

Training scientific writing skills.

Content

In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.

Prerequisites / notice

Attendance is mandatory.

651-4095-01L Colloquium Atmosphere and Climate 1

Abstract

The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Objective

The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

Biogeochemistry and Pollutant Dynamics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0534-00L</td>
<td>Chemical Kinetics in Terrestrial and Aquatic Systems</td>
<td>W</td>
<td>1</td>
<td>2G</td>
<td>S. Krämer</td>
</tr>
<tr>
<td>Objective</td>
<td>Theory of reaction kinetics. Derivation of rate laws. Evaluation of experimental data. Estimation of reaction rates from field observation. Mechanisms of kinetically controlled processes such as: reactions in the aquatic phase (complexation, redox processes); mineral surface reactions (adsorption, dissolution, precipitation, redox processes); reactions at gas/water interfaces; photochemical reactions; microbial/enzymatic reactions; reactions in stratified environments (soils, sediments).</td>
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<tr>
<td>Content</td>
<td>Lecture during lecture and on a course web-page.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Lecture for advanced and doctoral students. Course language is English. Lecture will be taught as a block in February. Exact dates will be announced.</td>
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<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.</td>
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<tr>
<td>Objective</td>
<td>The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.</td>
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<tr>
<td>Content</td>
<td>The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts will be distributed.</td>
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<tr>
<td>Literature</td>
<td>Will be mentioned in handouts.</td>
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<tr>
<td>701-1313-00L</td>
<td>Isotopic and Organic Tracers in Biogeochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Kipfer, C. Schubert</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course &quot;Isotopic and Organic Tracers Laboratory&quot;.</td>
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<tr>
<td>Objective</td>
<td>The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications</td>
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</tbody>
</table>
The course addresses major biogeochemical processes that drive the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.

**Abstract**
The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.

**Objective**
The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.

**Content**
- Interfacial processes and mechanisms by which microorganisms and plants interact with their extracellular environment, particularly with mineral surfaces.
- Reactions at mineral surfaces: precipitation, dissolution; redox reactions; photochemistry. Biological surfaces: structure of microbial cell surfaces; adsorption reaction at cell surfaces; structure of plant roots. Microbe / mineral interactions: recognition and chemotaxis; adhesion of microbes at mineral surfaces; enzymatic reactions at the cell/mineral interface; extracellular electron transfer; biomineralization; nutrient acquisition; interactions of nanoparticles with microbes; mineral weathering: microbial effects on contaminant mobility. Plant/mineral interactions: nutrient acquisition; mycorrhizal interactions with mineral surfaces.

**Prerequisites / notice**
Students are expected to familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

**Lecture notes**
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

**Prerequisites / notice**
Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent).

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**Eco-2023-01L**
**Title**: Seminar in Evolutionary Ecology of Infectious Diseases

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

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

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

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

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

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**Eco-2023-03L**
**Title**: Ecological Assessment and Evaluation

**Abstract**
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

**Objective**
Students will be asked to:
1) critically consider biological data books and local, regional, and national inventories;
2) evaluate the validity of ecological criteria used in decision making processes;
3) critically appraise the handling of ecological data and criteria used in the process of evaluation;
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

**Lecture notes**
Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

**Literature**
Basic literature and references are listed on the webpage.
The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.

Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbioökologie

**Research Seminar: Ecological Genetics**

- **Number of participants**: limited to 4.
- **Selection of the students**: order of registration.
- **Registration until**: 26.10.15

**Abstract**

In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

**Objective**

It is our aim that participants gain insight into the current research topics and knowledge available in Ecological Genetics and learn to critically assess and appreciate scientific publications in this field.

**Lecture notes**

Active participation in the discussions is a prerequisite for this course.

**Genetic Diversity: Techniques**

- **Number of participants**: limited to 8.
- **Selection of the students**: order of registration
- **Registration until**: 26.10.15

**Abstract**

This course provides training for advanced students (master, doctoral or post-doctoral level) in how to measure and collect genetic diversity data from populations, experiments, field and laboratory. Different DNA/RNA extraction, genotyping and gene expression techniques will be addressed. Choice of topic by demand and/or availability of data.

**Objective**

To learn and improve on standard and modern methods of genetic data collection. Examples are: use of pyrosequencing, expression analysis, SNP-typing, next-generation sequencing, etc. A course for practitioners.

**Content**

After an introduction (one afternoon), students will have 3 weeks to work independently or in groups through different protocols. At the end of the course students will present their work to the whole group.

**Lecture notes**

Material will be handed out in the course.

**Literature**

Material will be handed out in the course.

**Prerequisites / notice**

Two afternoons are held in the class. The lab work will be done from the students according to their timetable, but has to be finished after 3 weeks. Effort is roughly 1-2 days per week, depending on the skills of the student.

**Experimental Ecology: Evolution and Ecology**

- **Number of participants**: limited to 8.
- **Selection of the students**: order of registration
- **Registration until**: 26.10.15

**Abstract**

Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population biology.

**Objective**

Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in other groups.

**Content**

Scientific talks and discussions on changing subjects.

**Lecture notes**

None

**Literature**

None

**Prerequisites / notice**

For information and details: http://www.eco.ethz.ch/news/zis or contact: Lehrueve@env.ethz.ch

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**Human-Environment Systems**

- **Environmental Governance**
  - **Number**: 701-1651-00L
  - **ECTS**: 3
  - **Type**: W
  - **Hours**: 2G
  - **Lecturers**: E. Lieberherr; G. de Buren

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Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of technological change. Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

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

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

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

We will mostly work with readings from the following books:


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

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

<table>
<thead>
<tr>
<th>851-0589-00L</th>
<th>Technology and Innovation for Development</th>
<th>W 3 credits</th>
<th>2V</th>
<th>P. Aerni</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.</td>
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<tr>
<td>Objective</td>
<td>To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science. To analyze the evolution as well as the key elements of environmental governance. To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.</td>
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<tr>
<td>Content</td>
<td>Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.</td>
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<tr>
<td>Lecture notes</td>
<td>Reader with issue-specific articles. E-version is partly available under <a href="http://www.ib.ethz.ch/teaching/material/stpp">http://www.ib.ethz.ch/teaching/material/stpp</a></td>
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</tbody>
</table>

Literature


The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester.

The class will be taught in English.

Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

Abstract

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

Objective

At the end of the course students should:

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

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

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

Be prepared for:
- Transdisciplinary Case Study 2016

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

Handouts are provided by the lecturers

Selected scientific articles and book-chapters

This course is recommended for students participating in the Transdisciplinary Case Study 2016.

Abstract

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

The course is seminar-like, interactive.

Objective

At the end of the course students should

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

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

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1615-00L</td>
<td>Advanced Forest Pathology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>O. Holdenrieder, T. N. Sieber</td>
</tr>
<tr>
<td>701-1631-00L</td>
<td>Foundations of Ecosystem Management</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>J. Ghazoul, C. Garcia</td>
</tr>
<tr>
<td>701-1651-00L</td>
<td>Environmental Governance</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Lieberherr, G. de Buren</td>
</tr>
</tbody>
</table>

**Abstract**

Advanced Forest Pathology
- **Objective:** To know current biological and ecological research on selected diseases, to be able to comment on it and to understand the methods. To understand the dynamics of selected pathosystems and disturbance processes. To be able to diagnose tree diseases and injuries. To know forest protection strategies and to be able to comment on them.

Foundations of Ecosystem Management
- **Objective:** Students should be able to a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales; b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

Environmental Governance
- **Objective:** To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science. To analyze the evolution as well as the key elements of environmental governance. To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

**Literature**


**Prerequisites / notice**

The course is composed of introductory lectures, practical work, discussions and reading. The participants should have basic knowledge in forest pathoology (corresponding to the course 701-0563-00 “Wald- und Baumkrankheiten, see teaching book of H. Butin: Tree diseases and disorders, Oxford University Press 1995. 252 pp.”).
Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know

Introduction to design and model assisted sampling theory for finite populations as well as to the infinite population model for forest

Handouts will be available on the webpage of the course.


Sampling techniques for forest inventories, Daniel Mandallaz, 2007, Chapman and Hall.

M. Köhl, S. Magnussen, M. Marchetti, 2006, Springer.

Sampling methods, remote sensing and GIS multisource forest inventory


Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants


A simulation software will be used throughout the lectures to illustrate the theoretical developments. Upon request a half day field demonstration can be organized at the WSL outside the lecture time. A repetitorium for the exam is also offered.

Sampling Techniques for Forest Inventories

W 2 credits 2G 3 credits

D. Mandallaz


Sampling methods, remote sensing and GIS multisource forest inventory

M. Köhl, S. Magnussen, M. Marchetti, 2006, Springer.

Sampling techniques for forest inventories, Daniel Mandallaz, 2007, Chapman and Hall.


Prerequisites / notice

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

Sampling Techniques for Forest Inventories

W 3 credits 2V 4 credits

D. Mandallaz

Abstract

Introduction to design and model assisted sampling theory for finite populations as well as to the infinite population model for forest inventory. Two-phase two-stage forest inventories with simple or cluster sampling. Small area estimation. Presentation of the Swiss National Inventory.

Short introduction to Kriging techniques.

Objective

Students should have a good understanding of the concepts of general sampling theory in a modern framework. They should also master the specific problems arising in forest inventory and be able, if necessary, to read more specialized books or research papers.

Content


Lecture notes

Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants

Lecture notes

Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants

Literature


Sampling methods, remote sensing and GIS multisource forest inventory

M. Köhl, S. Magnussen, M. Marchetti, 2006, Springer.

Sampling techniques for forest inventories, Daniel Mandallaz, 2007, Chapman and Hall.


Prerequisites / notice

A simulation software will be used throughout the lectures to illustrate the theoretical developments. Upon request a half day field demonstration can be organized at the WSL outside the lecture time. A repetitorium for the exam is also offered.
Die Lehrveranstaltung gibt einen Einblick in die heutige Erdbeobachtung mit dem folgenden skizzierten Inhalt:

1. Einführung in die Fernerkundung von Luft- und Weltraum gestützten Systemen
2. Einführung in das Elektromagnetische Spektrum
3. Einführung in optische Systeme (optisch und hyperspektral)
4. Einführung in Mikrowellen-Technik (aktiv und passiv)
5. Einführung in atmosphärische Systeme (meteo und chemisch)
6. Einführung in die Techniken und Methoden zur Bestimmung von Umweltparametern
7. Einführung in die Anwendungen zur Bestimmung von Umweltparametern in der Hydrologie, Glaziologie, Forst und Landwirtschaft, Geologie und Topographie

Lecture notes
Literature
Ausgewählte Literatur wird am Anfang der Vorlesung vorgestellt.

701-1681-00L Element Balancing and Soil Functions in Managed Ecosystems

Abstract
Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

Objective
The students learn to critical assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.

Content
The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils.

Lecture notes
Literature
Literature will be provided.

Prerequisites / notice
The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours.

recommended prerequisites for attending this course:
- Bodenschutz und Landnutzung
- Biochemistry of Trace Elements
- Angewandte Bodenökologie

701-1776-00L Geographic Data Processing with Python and ArcGIS

Abstract
The course gives a general introduction into the geoprocessing framework of ArcGIS and shows how to use python scripts to access and automate geoprocessing tasks. Furthermore, the basics of the programming language Python will be communicated which is required for the implementation of multilevel spatial analysis and dynamic models.

Objective
The students learn the basics of geographic data processing based on the programming language Python and ArcGIS (arcpy). They get the ability to implement their own processing sequences and models for geoprocessing.

Content
The course communicates a deepend understanding of geoprocessing frameworks arcpy and covers basic language concepts of Python e.g. like control structures, functions and sequences.

Lecture notes
Literature
Lutz M. (2013); Learning Python, 5th Edition, O'Reilly Media

Prerequisites / notice
The course will be taught in German. All material will be provided in English. Knowledge of ArcGIS is assumed.

701-1682-00L Dendroecology

Abstract
The course dendroecology offers theoretical and practical aspects of dendrochronology. The impact of different environmental influences on tree-ring characteristics will be shown. The students learn various methods to date tree rings and they understand how ecological and environmental processes and patterns can be reconstructed using tree rings.

Objective
The students...
- understand, how wood is configured and how tree-ring structures are formed.
- are able to identify and describe different tree-ring structures.
- understand the theoretical and practical aspects of the dating of tree rings.
- know the effects of different abiotic and biotic environmental influences (climate, site, competition, insects, fire, physical-mechanical influences) on trees and tree rings.
- discover a tool for understanding and reconstructing global change processes.
- learn software to date, standardize and analyze tree rings.
- get hands-on experience based on the demonstration of wood (increment cores, stem discs, wedges), sampling in the field, and measuring and dating of tree rings in the tree-ring lab.
- solve R-based exercises (R tutorial will be provided) and answer questions in Moodle.
- work out an independent research question related to a dendroecological topic and write a short literature review based on scientific papers.
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

1. To acquire knowledge of key aspects of the interplay between science and practice
2. To reflect on and understand the role and consequences of scientific activity in relation to society and environment
3. To acquire skills and learn about a systematic application of methods to create and manage interactions between science and society
4. Collaborating disciplines
5. Exploration of tools and methods
6. Analysing participants' projects to improve inter- and transdisciplinary elements

The seminar covers the following topics:
- Principles and concepts of inter- and transdisciplinary research
- The specific challenges of inter- and transdisciplinary research
- Involved stakeholders
- Collaborating disciplines
- Exploration of tools and methods
- Analysing participants' projects to improve inter- and transdisciplinary elements

The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

The program will be announced through various channels and also be made available through the teaching materials.

The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

The class language is German and English, on request English only.

Prerequisites / notice

The CCES Winter School addresses PhD students and postdocs from environmental and natural sciences, engineering, and social sciences related to sustainable development. Participants are required to apply online providing key information about their interest and PhD project - details and application form can be found here: http://www.cces.ethz.ch/winterschool/

The Winter School runs with a maximum of 25 participants.

The Winter School 2015 is delivered by a diverse group of lecturers and experienced intermediaries.
- Carolina Adler (USYS TdLab, environmental philosophy group, ETH Zurich)
- Claudia Frick (sciencetext, HAFL Zollikofen)
- Martina Mittler (corporate communications, ETH Zurich)
- Patricia Fry (Wissensmanagement Umwelt GmbH)
- Pius Krütli (USYS TdLab, Natural and Social Science Interface, ETH Zurich)
- Christian Pohl (USYS TdLab, ETH Zürich & td-net, Bern)
- Michael Stauffacher (USYS TdLab, Natural and Social Science Interface, ETH Zurich)

The total time requirement is in the range of 120 hours, equivalent to 4 ECTS. The learning control focuses on i) active participation, engagement in case examples, and reflection against the background of own projects and experiences, 2) active team involvement in implementing tasks on information, consultation, and co-production of knowledge, including the design and organization of stakeholder meetings. The course is successfully completed by pass (pass/no pass, thus no marks). The language of the Winter School is English. Stakeholder meetings will be in the local language (Swiss German) and translation into English is provided.

There is a participation fee of 400 CHF for the course, which is a contribution to the costs for the two blocks at the seminar venue Propstei Wislikofen, organizational support as well as material for the stakeholder meetings. Travel expenses to the venue are to be borne by the participants.

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701-1505-00L “Global Water Challenges” Engineering for Development (E4D) Winter School

W 4 credits 4G to be announced


Abstract

The E4D winter school 2015 aims at an integrated vision of Global Water Challenges. The programme is designed to present water resources challenges that are of global relevance. Experts will outline the issues and will present their experiences working in different parts of the world. The programme will focus on three main topics: Water & Health, Water & Food, and Water & Energy, but it will also

Objective

The E4D winter school will be composed of 30 graduate students, 15 each from ETH Zurich and from other academic institutions, particularly from developing countries. They will be joined by faculty members and external experts from fields of expertise related to the winter school topic. The Master and PhD students will come from different disciplines related to the E4D topic.

During the first week, students will be introduced to fields relevant to the topic at hand through a series of input speeches, lectures and workshops conducted by experts. All participants will stay in a country house eco hotel in Emmental, 2h away from Zurich. During weeks two and three, students will relocate to ETH Zurich and be split into three thematic groups to carry out guided case studies. The case study work will provide them with hands-on opportunities to work in an interdisciplinary and intercultural team and to develop solutions to the chosen topic.
Three case studies will cover the following topics and will be based on modelling solutions in a specific country context:

**WATER, SANITATION AND HYGIENE (WASH)**

WASH is a UNICEF programme that is central to the millennium development agenda. In 2012, UNICEF expanded its support to WASH in Schools, which aims at providing gender-sensitive and child-friendly sanitation, washing, and water facilities to students. The purpose of this group work is to develop an integrated WASH programme for schools in Bolivia which would combine water treatment with hygiene awareness, handwashing, sanitation, etc. The group work will include field testing of existing household water treatment systems such as Sodis, gdm-filters, chlorination, and boiling with different types of water, as well as some lab analysis (microbial analysis).

**WATER ALLOCATION FOR FOOD AND ECOSYSTEM HEALTH**

The Yanqi Basin in Northwest China is an irrigation oasis. Agriculture is the main income of the population, but leads to numerous problems: salinization of soils due to groundwater table rise, increasing salinity of Lake Bosten, a fresh water lake receiving all drainage waters from the basin, diminished river flow in the downstream and die-off of Populus euphratica forests. You are supposed to formulate sustainability goals and find solutions for the allocation of water with regards to quantity and quality in order to have maximum agricultural production under constraints for soil salinity, downstream ecosystem health, lake salinity and lake water level. A MATLAB software is available which allows you to evaluate each course of action. A Pareto front between economic and ecological benefits should be identified and ideas for implementation should be formulated.

**EXPLORING THE ENERGY-WATER NEXUS IN THE KAFUE RIVER BASIN**

In the Kafue Flats, part of the Zambezi River Basin, the operation of two dams built in the seventies has completely altered the hydrological natural regime of this internationally important wetland. Backwater from downstream Katue Gorges reservoir and releases from upstream Thezi Thezi dam have created a permanently inundated area within the flats and reduced floods elsewhere, with large impacts on wildlife, vegetation and their dependent livelihoods. The group work will explore the water-energy nexus in the Flats from a multi-stakeholders perspective, by developing, based on the literature available, a set of indicators representing the main interests in the basin, including the ecosystem, the local population and the main economic sectors (sugar cane plantations and hydropower). Using a simplified model of the systems, several alternative operations of the systems (e.g., prioritizing different objectives) will be analysed to explore the tradeoffs among the interests of different stakeholders and explore options for more balanced and sustainable management.

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**Prerequisites / Notice**

The Engineering for Development (E4D) Winter School 2015 will invite 30 Master and PhD students from different disciplines related to the topic of "Global Water Challenges". Applicants will be selected based on their academic record and previous work experience, as well as their dedication to solving humanity's grand challenges. Applicants must send a one-page CV and one-page letter of motivation in PDF format stating their interest in one of the three themes:

Theme 1: Water and Health: Water, Sanitation, and Hygiene (WASH), Bolivia

Theme 2: Water and Food: Water allocation in China

Theme 3: Water and Energy: Exploring the water-energy nexus in the Katue river basin, Zambia

Admission will be for one of these three themes and cannot be altered once accepted.

Please send your full application to catherine.lippuner@sl.ethz.ch (resend your application if you did not receive an acknowledgement of receipt within two days).

Deadline: October 12, 2014

Notification: October 31, 2014

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**Basic and Scientific Skills**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-0019-00L</td>
<td>Readings in Environmental Thinking</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>J. Ghazoul, C. Garcia, G. Hirsch Hadorn</td>
</tr>
</tbody>
</table>

**Abstract**

This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, and shaped its relevance to society. Above all, the course seeks to give confidence and raise enthusiasm among students to read more widely around the broad subject of environmental sciences and management both during the course and beyond.

**Objective**

The course will provide students with opportunities to read, discuss, evaluate and interpret key texts that have shaped the environmental movement and, more specifically, the environmental sciences. Students will gain familiarity with the foundational texts, but also understand the historical context within which their academic and future professional work is based. More directly, the course will encourage debate and discussion of each text that is studied, from both the original context as well as the modern context. In so doing students will be forced to consider and justify the current societal relevance of their work.
### Content

The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is not a scientific paper) to identify the key points for discussion.

Thereafter, in each week a text (typically a chapter from a book or a paper) considered to be seminal or foundational will be assigned by a course lecturer. The lecturer will introduce the selected text with a brief background of the historical and cultural context in which it was written, with some additional biographical information about the author. He/she will also briefly explain the justification for selecting the particular text.

The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session. Presentation of the text requires the students to prepare by, for example:

- identifying the key points made within the text
- identifying issues of particular personal interest and resonance
- considering the impact of the text at the time of publication, and its importance now
- evaluating the text from the perspective of our current societal and environmental position

Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.

These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenting students will summarise the emerging points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes). In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.

### Literature

The specific texts selected for discussion will vary, but examples include:

- Leopold (1949) A Sand County Almanach
- Carson (1962) Silent Spring
- Jared Diamond (2005) Collapse

Discussions might also encompass films or other forms of media and communication about nature.

### Prerequisites / notice

- Particularly suitable for students of D-BIOL, D-CHAB, D-HEST

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<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Name</th>
<th>Credit Points</th>
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<tbody>
<tr>
<td>701-0017-00L</td>
<td>EAWAG PhD Skills Seminar</td>
<td>2 credits</td>
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<tr>
<td>701-0763-00L</td>
<td>Basic Concepts of Management</td>
<td>2 credits</td>
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<tr>
<td>851-0180-00L</td>
<td>Research Ethics</td>
<td>2 credits</td>
</tr>
</tbody>
</table>

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**Abstract**

**EAWAG PhD Skills Seminar**

Purpose is to discuss and teach the professional skills that are needed in science (or future career in science). Course consists of lectures and practical sessions. Course is organized by Eawag scientists.

**Objective**

Purpose is to discuss and teach the professional skills that are needed in science (or future career in science). Course consists of lectures and practical sessions.

**Content**

- Lectures and exercises in:
  - Project management
  - Application of research grants
  - Scientific publishing
  - Reviewing
  - Writing papers
  - Applying jobs
  - Job interviews

**Literature**


**Basic Concepts of Management**

This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioners; e.g. will Mr. S. Baldenweg, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures.

**Objective**

- Students will be familiar with basic general management concepts.
- Learn about the fundamental concepts of strategy development with practical examples.
- Get to know the basic organisational issues and the essential types of organisations.
- Get a rough overview on the concepts of financial management.
- Learn about the strategic positioning of small departments within larger organisations.
- Learn about the fundamental mechanisms for handling change, and will be able to recognise these situations.
- Will learn the basic principles of project management and of successful self-management.
- Will reflect on customer oriented information representation.

**Content**

- Management is a Massenberuf der durch klare Aufgaben and entsprechenden Werkzeuge beschrieben werden kann. Die Positionierung einer Firma, oder eines Bereiches bedingt die Analyse des Umfeldes and die Befassung mit den zukünftigen Herausforderungen. Dazu werden verschiedene Ansätze gezeigt and die grundlegenden Denkmuster vermittelt. Für die Umsetzung einer Strategie muss die Zusammenarbeit von Menschen entsprechend organisiert werden. Dazu werden die wesentlichen Organisationsmodelle and die Dynamik von Organisationen vermittelt.
- Die finanzielle Abbildung von Organisationen and Projekten wird übersichtsweise dargestellt and die stufengerechte Darstellung von Informationen anhand von realen Beispielen besprochen.
- Die Inhalte werden durchgängig mit Praxisbeispielen illustriert.

**Prerequisites / notice**

- Deutsch
Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.

Content
I. Ethics & the Process of Ethical Inquiry
---------------------------------------
Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------
Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

► Additional Courses

Course Catalogue of ETH Zurich

<table>
<thead>
<tr>
<th>Doctoral Department of Environmental Sciences - Key for Type</th>
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ECTS European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
## Electrical Engineering and Information Technology Bachelor

### 1. Semester

#### First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>401-0231-10L</td>
<td>Analysis I</td>
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<td>8</td>
<td>7G</td>
<td>A. lozzi</td>
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<td>Abstract</td>
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<tr>
<td></td>
<td>Calculus of one variable: Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations</td>
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<td>Einführung in die Grundlagen der Analysis</td>
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<td>Lecture notes</td>
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<td></td>
<td>Christian Blatter: Ingenieur-Analyse (Kapitel 1-3)</td>
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<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
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<td>4</td>
<td>3G+2U</td>
<td>V. C. Gradinaru</td>
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<td></td>
<td>Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.</td>
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<td>Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte</td>
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<td></td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002</td>
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<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002</td>
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<tr>
<td>252-0835-00L</td>
<td>Computer Science I</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>F. O. Friedrich</td>
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<td>Abstract</td>
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<td></td>
<td>The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required.</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens &quot;behind the scenes&quot; when a program is translated and executed.</td>
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<td></td>
<td>Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.</td>
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<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphism, simple dynamic data types are introduced as examples.</td>
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<td></td>
<td>In general, the concepts provided in the course are motivated and illustrated with algorithms and applications.</td>
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<td></td>
<td>Lecture notes</td>
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<td></td>
<td>A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page.</td>
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<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Bjørn Stroustrup: Einführung in die Programmierung mit C++, Pearson Studium, 2010</td>
<td></td>
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<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it.</td>
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<td></td>
<td>Examination is a one hour-long written test.</td>
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<tr>
<td>151-0223-10L</td>
<td>Engineering Mechanics</td>
<td>O</td>
<td>4</td>
<td>2V+2U+1K</td>
<td>S. P. Kaufmann, J. Dual</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<tr>
<td></td>
<td>Introduction to engineering mechanics: kinematics, statics and dynamics of rigid bodies and systems of rigid bodies.</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Basic notions: position and velocity of particles, rigid bodies, planar motion, kinematics of rigid body, force, couple, power.</td>
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<tr>
<td></td>
<td>Statics: static equivalence, force-couple system, center of forces, centroid, principle of virtual power, equilibrium, constraints, statics, friction.</td>
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<td></td>
<td>Dynamics: acceleration, inertial forces, d'Alembert's Principle, Newton's Second Law, principles of linear and angular momentum, equations of planar motion of rigid bodies.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<td>yes</td>
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<tr>
<td></td>
<td>Literature</td>
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<td>Prerequisites / notice</td>
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<td>Three optional midterm exams are offered. If improving, the mean of the two better midterm exams counts with weight 30% to the final grade.</td>
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</table>

### 2. Semester

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0001-00L</td>
<td>Networks and Circuits I</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>J. W. Kolar</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Electrostatic field; Stationary electric current flow; Basic electric circuits; current conduction mechanisms; time variant electromagnetic field; alternating voltages and currents.</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>Students can solve problems of elementary engineering mechanics.</td>
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<tr>
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<td>Content</td>
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<td>Voltage, current and properties of basic elements of electric circuits, i.e. capacitors, resistors and inductors should be understood in relation to electric and magnetic fields. Furthermore, the students should be able to mathematically describe, analyze and finally design technical realizations of circuit elements. Students should also be familiar with the calculation of voltage and current distributions of DC circuits. The effect and the mathematical formulation of magnetic induction should be known for technical applications. The fundamentals of complex AC current calculus for description of periodic sinusoidal quantities should be known and students should be able to apply the concept to basic AC circuits.</td>
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<td>Lecture notes</td>
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<td></td>
<td>Grundlagen der Elektrotechnik Bd. 1 und 2, M. Albach, and Textbook</td>
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<tr>
<td></td>
<td>Literature</td>
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<td></td>
<td>Grundlagen der Elektrotechnik</td>
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<tr>
<td>227-0003-00L</td>
<td>Digital Circuits</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>G. Tröster</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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</tbody>
</table>
Abstract
Digital and analogue signals and their representation. Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines. Memory and computing building blocks in CMOS technology, programmable logic circuits.

Objective
Provide basic knowledge and methods to understand and to design digital circuits and systems.

Content
Digital and analogue signals and their representation. Boolean Algebra, circuit analysis and synthesis, the MOS transistor, CMOS logic, static and dynamic behaviour, tristate logic, Karnaugh-Maps, hazards, binary number systems, coding. Combinational and sequential circuits and systems (boolean algebra, K-maps, etc.). Memory building blocks and memory structures, programmable logic circuits. Finite state machines, architecture of microprocessors.

Lecture notes
Lecture notes for all lessons, assignments and solutions.

Textbook: http://www.ife.ee.ethz.ch/education/Digitaltechnik

Literature
Literature will be announced during the lessons.

Prerequisites / notice
No special prerequisites

First Year Compulsory Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0005-10L</td>
<td>Digital Circuits Laboratory</td>
<td>O</td>
<td>1 credit</td>
<td>1P</td>
<td>G. Tröster</td>
</tr>
</tbody>
</table>

Abstract
Digital and analogue signals and their representation. Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines. Memory and computing building blocks in CMOS technology, programmable logic circuits.

Objective
Deepen and extend the knowledge from lecture and exercises, usage of design software Quartus II as well as an oscilloscope

Content
The contents of the digital circuits laboratory will deepen and extend the knowledge of the correspondent lecture and exercises. With the help of the logic device design software Quartus II different circuits will be designed and then tested on an evaluation board. You will build up the control for a 7-digit display as well as an adder and you will create different types of latches and flip-flops. At the end of the laboratory a small synthesizer will be programmed that is able to play self-created melodies. At the same time the usage of a modern oscilloscope will be taught in order to analyse the programmed circuits through the digital and analogue inputs.

3. Semester

Examination Blocks

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0353-00L</td>
<td>Analysis III</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>P. S. Jossen</td>
</tr>
</tbody>
</table>

Abstract
In this lecture we treat problems in applied analysis. The focus lies on the simplest cases of three fundamental types of partial differential equations of second order: the Laplace equation, the heat equation and the wave equation.

Content
1.) Klassifizierung von PDE's
   - linear, quasilinear, nicht-linear
   - elliptisch, parabolisch, hyperbolisch

2.) Quasilineare PDE
   - Methode der Charakteristiken (Beispiele)

3.) Elliptische PDE
   - Bsp: Laplace-Gleichung
   - Harmonische Funktionen, Maximumsprinzip, Mittelwerts-Formel.
   - Methode der Variablenseparation.

4.) Parabolische PDE
   - Bsp: Wärmeleitungsgleichung
   - Bsp: Inverse Wärmeleitungsgleichung
   - Methode der Variablenseparation

5.) Hyperbolische PDE
   - Bsp: Wellengleichung
   - Formel von d'Alembert in (1+1)-Dimensionen
   - Methode der Variablenseparation

6.) Green'sche Funktionen
   - Rechnen mit der Dirac-Deltafunktion
   - Idee der Green'schen Funktionen (Beispiele)

7.) Ausblick auf numerische Methoden
   - 5-Punkt-Diskretisierung des Laplace-Operators (Beispiele)

Literature

Zusätzliche Literatur:
Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, Kap. 8, 11, 16 (sehr gutes Buch, als Referenz zu benutzen)
Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen", vdf Hochschulverlag AG an der ETH Zürich.
G. Felder:Partielle Differentialgleichungen.
http://www.math.ethz.ch/u/felder/Teaching/PDG

Prerequisites / notice
Prerequisites: Analysis I and II, Fourier series (Komplexe Analysis)
Content
Die Grundlagen der Quantenphysik
Quantenmechanik
Wellenfunktion und Wahrscheinlichkeitsdichte, Schrödingergleichung, Potentialstufe, Teilchen im Potentialkasten, harmonische Oszillator, Tunnel Effekt, zeitabhängige Schrödingergleichung, Übergangswahrscheinlichkeiten und Auswahlregeln
Atome mit einem Elektron
Wasserstoffatom, Quantisierung des Dreimpulses, Einerlektronen-Wellenfunktion in Zentralfeldern, Zeeman-Effekt, Elektronenspin, Spin-Bahn-Wechselwirkung
Atome mit vielen Elektronen
Heilatome, Ausschliessungsprinzip, Elektronenstruktur der Atome, Röntgenspektren
Moleküle
Wasserstoffmolekül-Ion, Molekülwellenfunktion zweiseitomer Moleküle, Kövalente Bindung, Molekulare Rotation und Schwingung
Festkörper
Typen der Festkörper, Bändermodell der Festkörper, "Tight Binding Modell" explizit hergeleitet, Modell der freien Elektronen, Elektronenbewegung in einer periodischen Struktur, "effective mass approximation", Leiter, Isolator und Halbleiter, Quantentheorie der elektrischen Leitfähigkeit, Strahlungsübergänge in Festkörpern
Quantenstatistik
Fermi-Dirac Verteilung, Elektronengas, Elektronen in Metallen und Halbleiter (Anwendung der Fermi-Dirac Verteilung), Photonengas, Wärmekapazität von Festkörpern, ideale Gas in der Quantenstatistik

Lecture notes
Option: Phononen

Literature
Lehrbuch
Alonso, Marcelo / Finn, Edward J. Quantenphysik und Statistische Physik 5. Auflage aus 2011 978-3-486-71340-4
http://www.degruyter.com/view/product/221450?rskey=JqMV1g&result=1

Prerequisites / notice
Prerequisites: Physics I.

227-0045-00L Signals and Systems I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0071-00L</td>
<td>Electronic Circuits</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>H. Bölcskei</td>
</tr>
</tbody>
</table>

Abstract

Objective
Introduction to mathematical signal processing and system theory.

Content

Lecture notes
Lecture notes, problem set with solutions.

227-0013-00L Computer Engineering I

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0013-00L</td>
<td>Computer Engineering I</td>
<td>O</td>
<td>4</td>
<td>2V+1U+1P</td>
<td>L. Thiele</td>
</tr>
</tbody>
</table>

Abstract
The course provides knowledge about structures and models of digital systems (abstract data types finite state automata, dependence and process graphs), abstraction and hierarchy in computer systems, assembler and compiler, control path and data path, I/O, bus systems, memory hierarchy, operating system, pipelining, speculation techniques, superscalar computer architectures.

Objective
Logical and physical structure of computer systems. Introduction to principles in hardware design, datapath and control path, assembler programming, modern architectures (pipelining, speculation techniques, superscalar architectures), memory hierarchy, software concepts.

Content
Structures and models of digital systems (abstract data types finite state automata, dependence and process graphs), abstraction and hierarchy in computer systems, assembler and compiler, control path and data path, I/O, bus systems, memory hierarchy, operating system, pipelining, speculation techniques, superscalar computer architectures.

Lecture notes
Theoretical and practical exercises using a simulation-based infrastructure.

Literature

Prerequisites / notice
Prerequisites: Programming skills in high level language, knowledge of digital design.

Examination Block 2

Number | Title | Type | ECTS | Hours | Lecturers |
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</thead>
<tbody>
<tr>
<td>227-0071-10L</td>
<td>Electronic Circuits</td>
<td>O</td>
<td>4</td>
<td>2V+U</td>
<td>Q. Huang</td>
</tr>
</tbody>
</table>

Abstract
Introductory lecture on electronic circuits. Transistor fundamentals, analysis and design of transistor based electronic circuits such as amplifiers and filters; A/D- and D/A-converters, function generators, oscillators, PLLs.

Objective
Modern, transistor-based electronics has transformed our lives and plays a crucial role in our economy since the 2nd half of last century. The main objective of this course in electronic circuits is to introduce the concept of active device, including operational amplifiers, and their use in amplification, signal conditioning, switching and filtering to students. In addition to gaining experience with typical electronic circuits that are found in common applications, including their own Gruppenarbeit and Fachpraktikum projects, students sharpen their understanding of linear circuits based on nonlinear devices, imperfections of electronic circuits and the concept of design (as opposed to analysis). The course is a prerequisite for higher semester subjects such as analog integrated circuits, RF circuits for wireless communications, A/D and D/A converters and optoelectronics.

Content
The Laboratory courses in the 5th and 6th semesters enable the students to put the contents of the courses from the four first semesters to the test and to consolidate the acquired knowledge. Furthermore students have the possibility to gain specific knowledge in certain software packages as MATLAB.

Objective

Implementing the knowledge acquired during the basic studies.

Prerequisites / notice

Enrolment via Online-Tool (EE-Website: Studies -> Bachelor Program -> Third Year -> Laboratory Courses)
Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge.

Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during one's work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

Projects & Seminars for 2 CP (1)
Only for Electrical Engineering and Information Technology BSc.

Course can only be registered for once. A repeatedly registration in a later semester is not chargeable.

Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge.

Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during one's work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

Projects & Seminars for 2 CP (2)
Only for Electrical Engineering and Information Technology BSc.

Course can only be registered for once. A repeatedly registration in a later semester is not chargeable.

Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge.

Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during one's work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

Projects & Seminars for 3 CP
Only for Electrical Engineering and Information Technology BSc.

Course can only be registered for once. A repeatedly registration in a later semester is not chargeable.

Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge.

Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during one's work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

Projects & Seminars for 4 CP
Only for Electrical Engineering and Information Technology BSc.

Course can only be registered for once. A repeatedly registration in a later semester is not chargeable.

Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge.

Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during one's work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

Group Projects

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0091-10L</td>
<td>Group Project I</td>
<td>W</td>
<td>6 credits</td>
<td>5A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students must work in groups in supervised projects for 150 to 180 hours minimum. The topics of the group work are open and can be technical of specific nature or more general in the context of engineering.</td>
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<tr>
<td>Objective</td>
<td>see above</td>
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</table>

| 227-0091-10L | Group Project II | W    | 6 credits | 5A | Lecturers |
| Abstract    | Students must work in groups in supervised projects for 150 to 180 hours minimum. The topics of the group work are open and can be technical of specific nature or more general in the context of engineering. |
| Objective   | see above |

Internship in Industry

Please note the conditions for Internships in industry as set forward by the "Guidelines for the "Laboratory Courses - Projects - Seminars ", see https://www.ee.ethz.ch/content/dam/ethz/special-interest/let/department/Studies/Bachelor/Regulations/Richtlinien_Praktika-Projekte-Seminare_v5_final.pdf (German only).
The main objective of the 12-week internship is to expose bachelor's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Please note the conditions for Internships in industry as set forward by the "Guidelines for the "Laboratory Courses - Projects - Seminars ", see http://www.ee.ethz.ch/fileadmin/user_upload/d-lab/nuwe_website/Factsheets/Reglemente/Richtlinien_Praktika-Projekte-Seminare_v5_final.pdf (German only).

Additional Subjects

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0651-00L</td>
<td>Applied Circuit and PCB-Design</td>
<td>W</td>
<td>2 credits</td>
<td>4G</td>
<td>D. Schöni</td>
</tr>
</tbody>
</table>

Participants learn how to design a predefined electronic circuit and how to lay out the pertaining circuit board. CAE and CAD activities for design and simulation is carried out with the aid of Altium Designer.

The goal is to become acquainted with all those practical aspects of electronic circuit and PCB design by working through a modest but complete application example. This involves analysis of specifications, the evaluation of electronic parts, efficient testing and failure search, electromagnetic compatibility (EMC), the usage of industrial CAE/CAD tools for circuit simulation and PCB layout, generating production data for the board manufacturer, board mounting, testing and start up.

Content:

- Understanding circuit, system, and product specifications
- Guidelines, standards, and regulations
- Design and development flow
- Introduction to the Altium Designer environment
- Selection of components and circuit sizing
- Preparing schematic symbols and footprints for CAE/CAD
- Working with database component libraries
- Logically structured schematic circuit diagrams
- Capturing a predefined circuit
- Definition of net classes and layout rules in schematics
- Design for EMC
- Checking schematic data
- Simulation of mixed signal circuits using Spice
- Hints for improved testing and debugging
- Component placement on the PCB
- Turning circuit diagrams into a workable layout
- Manual and automatic interconnect routing
- Definition of layout rules
- RF- and EMC-guidelines for circuit wire routing
- Differential pairs and impedance-controlled routing
- Introduction to PCB manufacturing
- Preparation of production and assembly data
- PCB and device assembly (component mounting)
- Final circuit testing and start up

Prerequisites / notice

- The course is recommended to all students who plan to design an electronic circuit or a PCB in an upcoming term project or as part of their master thesis. Attending this course during the term before will ensure they are optimally prepared and will allow them to fully focus on their project.
- The number of participants is limited.
- For their own students and staff, the Department of Information Technology and Electrical Engineering provides electronic components and consumables free of charge. All other participants have to bear a 200 CHF fee for those items.
Abstract
Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective
Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

Content
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes
Available

Literature
[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser

227-0103-00L Control Systems W 6 credits 2V+2U M. Morari, F. Dörfler

Abstract
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective

Content
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes
Available

Literature

Prerequisites / notice
Prerequisites: Signal and Systems Theory II.
MATLAB is used for system design and simulation.

227-0112-00L High-Speed Signal Propagation W 6 credits 2V+2U C. Bolognesi

Abstract
Understanding of high-speed signal propagation in microwave cables and integrated circuits and printed circuit boards.

As clock frequencies rise in the GHz domain, there is a need grasp signal propagation to maintain good signal integrity in the face of symbol interference and cross-talk.

The course is of high value to all interested in high-speed analog (RF, microwave) or digital systems.

**Objective**

Understanding of high-speed signal propagation in interconnects, microwave cables and integrated transmission lines such as microwave integrated circuits and/or printed circuit boards.

As system clock frequencies continuously rise in the GHz domain, a need urgently develops to understand high-speed signal propagation in order to maintain good signal integrity in the face of phenomena such as inter-symbol interference (ISI) and cross-talk.

Concepts such as Scattering parameters (or S-parameters) are key to the characterization of networks over wide bandwidths. At high frequencies, all structures effectively become "transmission lines." Unless care is taken, it is highly probable that one ends-up with a bad transmission line that causes the designed system to malfunction.

Filters will also be considered because it turns out that some of the problems associated with lossy transmission channels (lines, cables, etc) can be corrected by adequate filtering in a process called "equalization."

**Content**


Scattering parameters.

Butterworth-, Chebychev- and Bessel filter approximations: filter synthesis from low-pass filter prototypes.

Script: Leitungen und Filter (In German).

**Prerequisites / notice**

Exercises will be held in German, but assistants also speak English.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
</tr>
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<tbody>
<tr>
<td>227-0113-00L</td>
<td>Power Electronics</td>
<td>6</td>
<td>W</td>
<td>J. W. Kolar</td>
</tr>
<tr>
<td>227-0121-00L</td>
<td>Communication Systems</td>
<td>6</td>
<td>W</td>
<td>A. Wittneben</td>
</tr>
<tr>
<td>227-0122-00L</td>
<td>Introduction to Electric Power Transmission: System &amp; Technology</td>
<td>6</td>
<td>W</td>
<td>C. Franck, G. Hug</td>
</tr>
<tr>
<td>227-0145-00L</td>
<td>Solid State Electronics</td>
<td>6</td>
<td>W</td>
<td>V. Wood</td>
</tr>
<tr>
<td>227-0166-00L</td>
<td>Analog Integrated Circuits</td>
<td>6</td>
<td>W</td>
<td>Q. Huang</td>
</tr>
</tbody>
</table>
Objective
Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

Content
- The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

Abstract
Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc.; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.

The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.

Literature
- Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Notice
This is but a short selection. Other courses from the ETH course catalogue may be chosen. Please consult the “Richtlinien zu Projekten, Praktika, Seminare” (German only), published on our website (http://www.ee.ethz.ch/pps-richtlinien).

Electives

Man-Technology-Environment Electives (“MTU”)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0802-01L</td>
<td>Social Psychology</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>H.D. Daniel, R. Mutz</td>
</tr>
<tr>
<td>227-0802-02L</td>
<td>Sociology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. Diekmann</td>
</tr>
</tbody>
</table>

Objective
- To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Literature
- Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011
- S. Kozerke

Prerequisites / notice
- Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

Folgende Themen werden behandelt:


Gruppenarbeiten

- Schriftliche Arbeit in Soziologie (Durchführung einer kleinen empirischen Studie, Konstruktion eines Simulationsmodells sozialer Prozesse oder Diskussion einer vorliegenden soziologischen Untersuchung).

Literature

- Folien der Vorlesung im Internet
- Handouts (available online)
- Lecture notes: Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library)
- Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=1596).

### Engineering Electives

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
151-0621-00L | Microsystems Technology | W | 6 credits | 4G | C. Hierold, M. Haluska

**Abstract**

This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

**Objective**

Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

**Content**

Basic concepts of law, sources of law.

Private law: Contract law (particularly contract for work and services), tort law, property law.

Public law: Human rights, administrative law, procurement law, procedural law.

Insights into the law of the EU and into criminal law.

**Lecture notes**

Handouts (available online)

- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O.Paul: Microsystem Technology
- G. Kovacs: Micromachined Transducer Sourcebook

**Prerequisites / notice**

Prerequisites: Physics I and II

### Economic Science Electives

These subjects are particularly suitable for students planning to apply to the Master's Degree Program in Energy Science and Technology (MSc EST) or Management, Technology and Economics (MSc MTEC).

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
363-0305-00L | Empirical Methods in Management | W | 3 credits | 2G | A. Scherer
Abstract
Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

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

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

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

Class participation: Class participation is encouraged and can greatly improve students' learning in this class. Class participation will not be graded; however, it will be considered favorably if a student is between grades. Note, however, that quality is more important than quantity. In this spirit, students are expected to attend class regularly and come to class prepared.

363-0503-00L
Principles of Microeconomics
W 3 credits 2G M. Filippini

Abstract
The course introduces basic principles, problems and approaches of microeconomics.

Objective
The course includes the following main topics:

- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour,
- economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

Lecture notes
Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature

The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:


Complementary:

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-ITET.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Electrical Engineering and Information Technology Bachelor - Key for Type O

W+ Eligible for credits and recommended
W Eligible for credits

Key for Hours
V lecture
G lecture with exercise
U exercise
S seminar
K colloquium

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma, MAS SHE and TC".

### Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
851-0240-22L | Coping with Psychosocial Demands of Teaching (EW4 W DZ) | | 2 credits | 3S | A. Deiglmayr, P. Greutmann, S. Hofer

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

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

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).

(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

851-0242-06L | Cognitively Activating Instructions in MINT Subjects | W | 2 credits | 2S | R. Schumacher

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

Objective
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

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

851-0242-07L | Human Intelligence | W | 1 credit | 1S | E. Stern, P. Edelsbrunner, B. Rütsche

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

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

851-0242-08L | Research Methods in Educational Science | W | 1 credit | 1S | P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler

Abstract
Literature from the learning sciences is critically discussed with a focus on research methods.

At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

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

Subject Didactics and Professional Training

### Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
227-0859-00L | Teaching Internship Including Examination Lessons Electrical Engineering and Information Technology | W | 4 credits | 9P | M. Thaler

The teaching internship can only be visited if all other courses of TC have been completed.

Repétition of the teaching internship is no possible, also if the examination lessons have to be repeated.

Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.
Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

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

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

Content

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature
Wird von der Praktikumskolleginh/innen bestimmt.

227-0859-10L Teaching Internship Including Examination Lessons Electrical Engineering and Information Technology

W 6 credits 13P M. Thaler

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

The teaching internship can just be visited if all other courses of TC are completed.

Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
- Gelenktes Entdeckendes Lernen
- Puzzle
- Werkstatt
- Projektarbeit

Zu diesen Themen sind die vorhandenen Manuals aus den IfV zu verwenden, bzw. wo nötig zu adaptieren.

Lecture notes
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.
Subject Didactics I for D-MAVT and D-ITET

Abstract
Didactical methods in mechanical and electrical engineering.
- The students can plan, conduct and critically reflect single lessons.
- They orient themselves towards the academic goals and take into account existing knowledge, the professional environment and the ambitions of the students.
- They can apply the basic teaching principles meaningfully in their subject and suitably structure the learning phases.
- They can reduce and present complex technical content such that it is in a form suitable for the students to learn.
- They have considered examples of the common conceptual errors encountered by students

Objective
- Didactic analysis
- Competences and goals
- Preparation and wrap-up of lessons
- Process and structure of a typical lesson
- Teaching techniques (informative introduction to lessons, Advance Organizer, learning assignments, frontal teaching, questions, assignments, feedback)
- Assignments and short tests
- Media and language competence
- Conceptual change, misconceptions,
- Integration of the subcomponents of a lesson.

Content
- Didactic analysis
- Competences and goals
- Preparation and wrap-up of lessons
- Process and structure of a typical lesson
- Teaching techniques (informative introduction to lessons, Advance Organizer, learning assignments, frontal teaching, questions, assignments, feedback)
- Assignments and short tests
- Media and language competence
- Conceptual change, misconceptions,
- Integration of the subcomponents of a lesson.

Literature

Prerequisites / notice
Voraussetzung: Erziehungswissenschaftliche Lehrveranstaltung schon absolviert oder gleichzeitig.

Further Subject Didactics

Number Title Type ECTS Hours Lecturers
227-0854-00L Mentored Work Subject Didactics Electrical Engineering and Information Technology II O 2 credits 4A M. Thaler

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content

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

Literature
K. Frey, Allgemeine Didaktik, FH-Skript bzw. Lehrbuch des Praktikumslehrers.

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

Electrical Engineering and Information Technology TC - Key for Type

O Compulsory E- Recommended, not eligible for credits
W+ Eligible for credits and recommended Z Courses outside the curriculum
W Eligible for credits Dr Suitable for doctorate
<table>
<thead>
<tr>
<th>Key for Hours</th>
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</tr>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### VLSI II: Design of Very Large Scale Integration Circuits

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>227-0147-00L</td>
<td>VLSI II: Design of Very Large Scale Integration Circuits</td>
<td>W</td>
<td>7</td>
<td>5G</td>
<td>H. Kaeslin, N. Felber</td>
</tr>
</tbody>
</table>

**Abstract**

This second course in our VLSI series is concerned with how to turn digital netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects (clock skew, metastability, ground bounce, IR-drop, electromigration, ESD, latchup). Economic aspects and management issues of VLSI projects are also addressed.

**Objective**

Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.

**Content**

- The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:
  - Limitations of functional design verification, design for test.
  - Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.
  - Synchronization and metastability.
  - CMOS transistor-level circuits of gates, flip-flops and random access memories.
  - Sinks of energy in CMOS circuits.
  - Power estimation and low-power design.
  - Current research in low-energy computing.
  - Layout parasitics, interconnect delay, static timing analysis.
  - Switching currents, ground bounce, IR-drop, power distribution.
  - Floorplanning, chip assembly, packaging.
  - Layout design at the mask level, physical design verification.
  - Electromigration, electrostatic discharge, and latch-up.
  - Models of industrial cooperation in microelectronics.
  - The caveats of virtual components.
  - The cost structures of ASIC development and manufacturing.
  - Market requirements, decision criteria, and case studies.
  - Yield models.
  - Avenues to low-volume fabrication.
  - Marketing aspects and case studies.
  - Management of VLSI projects.

Exercises are concerned with back-end design (floorplanning, placement, routing, clock and power distribution, layout verification). Industrial CAD tools are being used.

**Prerequisites / notice**

- All written documents in English.

**Lecture notes**

- English lecture notes.

**Literature**

- H.A. Loeliger

**Further details**

Wireless access systems support locally constrained wireless connectivity and mobile access to a backbone network (typically the Internet). In this course the student develops a comprehensive understanding of existing and upcoming wireless access technologies (including WiFi, Bluetooth, RFID, NFC, VANET) and related Physical Layer and Medium Access Control Layer problems and opportunities.

The course consists of two tracks. The track “Technology&Systems” is structured as regular lecture. In the introduction we will discuss the challenges and potential of pervasive wireless access and study some fundamentals of short/medium range wireless communications. The main body of this track is devoted to existing and upcoming systems. A comprehensive survey of Ultrawide band (UWB) as the promising transmission technology for pervasive wireless access completes this track. In the track “Simulate&Practice” we form student teams that implement and analyze functional blocks of the physical layer of various advanced wireless access systems based on MATLAB simulations. The track includes combination tasks where different teams combine their functional blocks (e.g., transmitter, receiver) in order to simulate the complete physical layer.

1. Short range wireless communication : fundamental Physical Layer challenges and solutions
2. Wireless Local Area Network (WLAN)
3. Vehicular Networks (VANET)
4. Ultra-Wideband (UWB) technology: fundamental principles, promises and solutions
5. Wireless Body Area Networks (WBAN)
6. Wireless Personal Area Networks (Bluetooth, Zigbee)
7. Radio Frequency Identification (RFID) and Near Field Communication (NFC)

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0102-00L</td>
<td>Discrete Event Systems</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>L. Thiele, L. Vanbever, R. Wattenhofer</td>
</tr>
</tbody>
</table>

Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>227-0103-00L</td>
<td>Control Systems</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>M. Morari, F. Dörfler</td>
</tr>
</tbody>
</table>

Transmission line equations of the lossless and lossy TEM-transmission line. Introduction of current and voltage waves. Representation of understanding of high-speed signal propagation in interconnects, microwave cables and integrated transmission lines such as microwave.

The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is.

As clock frequencies rise in the GHz domain, there is a need grasp signal propagation to maintain good signal integrity in the face of symbol interference and cross-talk.

The course is of high value to all interested in high-speed analog (RF, microwave) or digital systems.

As system clock frequencies continuously rise in the GHz domain, a need urgently develops to understand high-speed signal propagation in order to maintain good signal integrity in the face of phenomena such as inter-symbol interference (ISI) and cross-talk.

Concepts such as Scattering parameters (or S-parameters) are key to the characterization of networks over wide bandwidths. At high frequencies, all structures effectively become "transmission lines." Unless care is taken, it is highly probable that one ends-up with a bad transmission line that causes the designed system to malfunction.

Filters will also be considered because it turns out that some of the problems associated by lossy transmission channels (lines, cables, etc) can be corrected by adequate filtering in a process called "equalization."


Script: Leitungen und Filter (In German).

Exercises will be held in German, but assistants also speak English.

Filters will also be considered because it turns out that some of the problems associated by lossy transmission channels (lines, cables, etc) can be corrected by adequate filtering in a process called "equalization."

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements.

The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system.

The lecture notes of presented slides. No script but an accompanying textbook is recommended.

The objective is to study the transmission of a signal from source to destination. Also the mathematical framework to describe the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications.
Physics of Failure and Failure Analysis of Electronic Devices and Equipment

Abstract
Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

Objective
Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

Content
Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis

Lecture notes
Comprehensive copy of transparencies

Image Analysis and Computer Vision

Abstract
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Objective
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Content
About objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed. The course language is English.

Prerequisites
Course material Script, computer demonstrations, exercises and problem solutions

Lecture notes
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

Advanced Mathematical Signal Processing

Abstract
Usually Fourier Analysis and Systems Theory emphasize the analogy between the different settings (continuous&discrete, periodic&non-period.). The author proposes a simple approach to generalized functions, based on a Banach space of test functions. The course provides the foundations to Banach Gelfand triples, but also concrete applications in signal processing (time-variant systems, sampling).

Objective
Deeper mathematical understanding of the foundations of signal processing and system theory. The setting of Banach Gelfand Triangles allows to provide a framework that allows among others to discuss the relations between different settings (e.g. the generalized Fourier transform of functions on the Euclidean space and corresponding FFT-based routines).

Content
Time-Frequency Analysis and its discretized version, namely Gabor Analysis have required to develop a family of function spaces (the so-called modulation spaces, introduced by Feichtinger in the 80th) which is different from the usual Lebesgue spaces. There is a smallest space (called S_0) and a largest space (namely the dual space), which is a suitable reservoir of generalized functions relevant for the rigorous establishment of basic results in signal processing (sampling theorem, Poisson formula, Fourier inversion, etc.). The course will be centered about the basic properties of the Banach Gelfand triple (S_0,L2,S_0') (also called rigged Hilbert space), its use for signal processing and systems theory applications. In addition to classical questions we will also discuss the fundamental results of time-frequency analysis (Short-time Fourier transform, Gabor frames, Gabor multipliers, best approximation of operators by Gabor multipliers, identification of slowly varying channels using pilot tones, etc.).

Lecture notes
There will a script related to the course. In fact, material for a book project on the subject is developed while the course is given. We will, however, explain all these concepts as we go along. We will not need background on Lebesgue integration or topological vector spaces (as usually required for the treatment of distributions).

Analog Signal Processing and Filtering

Abstract
This lecture provides a wide overview about analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers.

Lecture notes
Suitable for Master Students as well as Doctoral Students.
Objective

This lecture provides a wide overview about analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers. The way the exam is done allows for the different interests of the two groups.

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.

Content

At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

Lecture notes

The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.

Details: https://people.ee.ethz.ch/~haschmid/asfwiki/

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.

Prerequisites / notice

Prerequisites: Recommended (but not required): Stochastic models and signal processing, Communication Electronics, Analog Integrated Circuits, Transmission Lines and Filters.

Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria ...) and of the main properties of linear systems is necessary.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Weeks</th>
<th>Credits</th>
<th>Additional Credits</th>
<th>Author</th>
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<tbody>
<tr>
<td>227-0477-00L</td>
<td>Acoustics I</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>K. Heutschi</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Introduction to the fundamentals of acoustics in the area of sound field calculations, measurement of acoustical events, outdoor sound propagation and room acoustics of large and small enclosures.</td>
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<td></td>
<td>Introduction to acoustics. Understanding of basic acoustical mechanisms. Survey of the technical literature. Illustration of measurement techniques in the laboratory.</td>
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<td>Fundamentals of acoustics, measuring and analyzing of acoustical events, anatomy and properties of the ear. Outdoor sound propagation, absorption and transmission of sound, room acoustics of large and small enclosures, architectural acoustics, noise and noise control, calculation of sound fields.</td>
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<td></td>
<td>G. DeMicheli, R. Ernst and W. Wolf, Readings in Hw/Sw Co-design, M. Kaufmann, 2003.</td>
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<td>227-0778-00L</td>
<td>Hardware/Software Codeign</td>
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<td>6</td>
<td>2V+2U</td>
<td>L. Thiele</td>
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<td></td>
<td>Abstract</td>
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<td>The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration).</td>
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<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
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<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<td>The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<td>Topics covered in the lecture include:</td>
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<td>- Bayesian theory of optimal decisions</td>
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<td>- Maximum likelihood and Bayesian parameter inference</td>
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<td>- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)</td>
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<td>- Ensemble methods: Bagging and Boosting</td>
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<td>- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off</td>
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<td>- Non parametric density estimation: Parzen windows, nearest neighbour</td>
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<td></td>
<td>- Dimension reduction: principal component analysis (PCA) and beyond</td>
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<td>Lecture notes</td>
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<td>No lecture notes, but slides will be made available on the course webpage.</td>
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</table>
The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

Students know fundamental network security concepts.

Students know how to configure a real firewall and know some penetration testing tools from their own experience.

Primary literature for exercises and labs includes:

Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

253-4640-00L Network Security W 6 credits 2V+1U+2P A. Perrig, T. P. Dübendorfer, S. Frei
Abstract
This lecture discusses fundamental concepts and technologies in the area of network security. Several case studies illustrate the dark side of the Internet and explain how to protect against such threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

Objective
Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures. Students can identify and assess known vulnerabilities in a software system that is connected to the Internet.

Content
Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture. This lecture and the exam are held in English.

Prerequisites / notice
Knowledge in computer networking and Internet protocols (e.g. course Communication Networks (D-ITET) or Operating Systems and Networks (D-INFK)).

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

Core Subjects
These core subjects are particularly recommended for the field of "Computers and Networks".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
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<td>Hardware/Software Codesign</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>L. Thiele</td>
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<tr>
<td>Literature</td>
<td>Material for exercises, copies of transparency.</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>227-0781-00L</td>
<td>Low-Power System Design</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>J. Beutel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to low-power and low-energy design techniques from a systems perspective including aspects both from hard- and software. The focus of this lecture is on cutting across a number of related fields discussing architectural concepts, modeling and measurement techniques as well as software design mainly using the example of networked embedded systems.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of the state-of-the-art in low power system design, understanding recent research results and their implication on industrial products.</td>
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<td>Content</td>
<td>Designing systems with a low energy footprint is an increasingly important. There are many applications for low-power systems ranging from mobile devices powered from batteries such as today's smart phones to energy efficient household appliances and datacenters. Key drivers are to be found mainly in the tremendous increase of mobile devices and the growing integration density requiring to carefully reason about power, both from a provision and consumption viewpoint. Traditional circuit design classes introduce low-power solely from a hardware perspective with a focus on the power performance of a single or at most a hand full of circuit elements. Similarly, low-power aspects are touched in a multitude of other classes, mostly as a side topic. However in successfully designing systems with a low energy footprint it is not sufficient to only look at low-power as an aspect of second class. In modern low-power system design advanced CMOS circuits are of course a key ingredient but successful low-power integration involves many more disciplines such as system architecture, different sources of energy as well as storage and most importantly software and algorithms. In this lecture we will discuss aspects of low-power design as a first class citizen introducing key concepts as well as modeling and measurement techniques focusing mainly on the design of networked embedded systems but of course equally applicable to many other classes of systems. The lecture is further accompanied by a reading seminar as well as exercises and lab sessions.</td>
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<tr>
<td>Literature</td>
<td>Exercise and lab materials, copies of lecture slides.</td>
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</table>

The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. In the second part, the focus is on system design and methodologies for large projects.

In this lecture, students learn about the security requirements and capabilities that are expected from modern hardware, operating systems and other software environments. An overview of available technologies, algorithms and standards is given, with which these requirements can be met.

The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over networking services and networked devices face and can explain appropriate countermeasures. Students know how to configure a real firewall and know some penetration testing tools from their own experience.

The first part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm.

This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture. This lecture and the exam are held in English.

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

Recommended Subjects

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0101-00L</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>H.A. Looliger</td>
</tr>
<tr>
<td>227-0103-00L</td>
<td>Control Systems</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>M. Morari, F. Dörfler</td>
</tr>
</tbody>
</table>

Data: 06.12.2018 13:04  
Autumn Semester 2015  
Page 462 of 1432
### Literature

### Prerequisites / notice
MATLAB is used for system analysis and simulation.

### 227-0197-00L Wearable Systems I

**Abstract**
Context recognition in mobile communication systems like mobile phone and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning. Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

**Objective**
Future mobile systems will act as personal and cooperative assistant by providing the appropriate information and services. The systems consist of a smart phone which communicates with sensors on-body and in the environment. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

**Content**
The next generation of mobile communication systems are integrated in our clothes and act as personal and cooperative assistant providing information we need just now (see www.wearable.ethz.ch). Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include:
- Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, kNN-Methods, Support Vector Machine, Hidden Markov Models, AdaBoost), clustering (k-means, dbscan, topic models)
- Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

**Language:** german/english (depending on the participants)

**Lecture notes**
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1

**Literature**
- Literature will be announced during the lessons.
- No special prerequisites

### 227-0377-00L Physics of Failure and Failure Analysis of Electronic Devices and Equipment

**Abstract**
Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

**Objective**
Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

**Content**
Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis.

**Lecture notes**
Comprehensive copy of transparencies

### 252-0437-00L Distributed Algorithms

**Abstract**
Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversal, consistent snapshots, mutual exclusion, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.

**Objective**
Become acquainted with algorithms for distributed systems.

**Content**
Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonome Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschliesslich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Ubertragungszustand von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuelle konsistente Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen.

Im einzelnen werden u.a. folgende Themen behandelt:
- Modell verteilter Berechnungen; Raum-Zeit Diagramme; Virtuelle Zeit; Logische Uhren und Kausalität; Wellenalgorithmen; Verteilte und parallele Graphtraversierung; Berechnung konsistenter Schnappschüsse; Wechselseitiger Ausschluss; Election und Symmetriebrechung;
- Verteilte Terminierung; Garbage-Collection in verteilter Systemen; Beobachten verteilter Systeme; Berechnung globaler Prädikate.

**Literature**
- F. Mattern: Verteilte Basialgorithmen, Springer-Verlag
- G. Tel: Topics in Distributed Algorithms, Cambridge University Press
- G. Tel: Introduction to Distributed Algorithms, Cambridge University Press, 2nd edition
- N. Lynch: Distributed Algorithms, Morgan Kaufmann Publ

### 227-0447-00L Image Analysis and Computer Vision

**Abstract**

**Objective**
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.
We discuss fault-tolerance issues (models, consensus, agreement) as well as replication issues (primary copy, 2PC, 3PC, Paxos, quorum systems), shared memory (spin locks, concurrency).


Script and exercise sheets.

R. Wattenhofer

Understand the function, the design and the performance modeling of parallel computer systems.

W

3G

This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

After this course, the students should be able to:
- Describe and classify security goals and attacks in wireless networks;
- Describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

Lecture notes
Prerequisites / notice

Prerequisites:
- Basics of computer architecture.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: schmid@idsc.mavt.ethz.ch)

After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

151-0593-00L Embedded Control Systems W 4 credits 6G J. S. Freudenberg, M. Schmid Daners

Abstract
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

Objective
Familiarize students with main architectural principles and concepts of embedded control systems.

Content
An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

- Subjects covered in lectures and practical lab exercises include:
  - The application of C-programming on a microprocessor
  - Digital I/O and serial communication
  - Quadrature decoding for wheel position sensing
  - Queued analog-to-digital conversion to interface with the analog world
  - Pulse width modulation
  - Timer interrupts to create sampling time intervals
  - System dynamics and virtual worlds with haptic feedback
  - Introduction to rapid prototyping

Lecture notes
Prerequisites / notice

Prerequisite courses are Control Systems I and Informatics I.

This course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

252-1411-00L Security of Wireless Networks W 5 credits 2V+1U+1A S. Capkun

Abstract
Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques.

Objective
After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.

Content


Electronics and Photonics

Core Subjects

These core subjects are particularly recommended for the field of “Electronics and Photonics”.

Number Title Type ECTS Hours Lecturers
227-0147-00L  VLSI II: Design of Very Large Scale Integration Circuits

Abstract
This second course in our VLSI series is concerned with how to turn digital netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects (clock skew, metastability, ground bounce, IR-drop, electromigration, ESD, latchup). Economic aspects and management issues of VLSI projects are also addressed.

Objective
Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.

Content
The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:
- Limitations of functional design verification, design for test.
- Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.
- Synchronization and metastability.
- CMOS transistor-level circuits of gates, flip-flops and random access memories.
- Sinks of energy in CMOS circuits.
- Power estimation and low-power design.
- Current research in low-energy computing.
- Layout parasitics, interconnect delay, static timing analysis.
- Switching currents, ground bounce, IR-drop, power distribution.
- Floorplanning, chip assembly, packaging.
- Layout design at the mask level, physical design verification.
- Electromigration, electrostatic discharge, and latch-up.
- Models of industrial cooperation in microelectronics.
- The caveats of virtual components.
- The cost structures of ASIC development and manufacturing.
- Market requirements, decision criteria, and case studies.
- Yield models.
- Avenues to low-volume fabrication.
- Marketing aspects and case studies.
- Management of VLSI projects.

Lecture notes
English lecture notes.

Literature

Prerequisites / notice
Highlight:
Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:
"VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs" or equivalent knowledge.

Further details:
http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

227-0197-00L  Wearable Systems I

Abstract
Context recognition in mobile communication systems like mobile phone and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.

Objective
Future mobile systems will act as personal and cooperative assistant by providing the appropriate information and services. The systems consist of a smart phone which communicates with sensors on-body and in the environment. Context comprises user's behavior, his activities, his local and social environment.

Content
In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

The next generation of mobile communication systems are integrated in our clothes and act as personal and cooperative assistant providing information we need just now (see www.wearable.ethz.ch). Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include
- The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Lecture notes
Language: german/english (depending on the participants)

Literature
http://www.ife.ee.ethz.ch/education/wearable_systems_1

Prerequisites / notice
No special prerequisites

227-0301-00L  Optical Communication Fundamentals

Abstract

Objective

Content

Lecture notes

Literature

Prerequisites / notice

227-0147-00L  VLSI II: Design of Very Large Scale Integration Circuits

Abstract
This second course in our VLSI series is concerned with how to turn digital netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects (clock skew, metastability, ground bounce, IR-drop, electromigration, ESD, latchup). Economic aspects and management issues of VLSI projects are also addressed.

Objective
Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.

Content
The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:
- Limitations of functional design verification, design for test.
- Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.
- Synchronization and metastability.
- CMOS transistor-level circuits of gates, flip-flops and random access memories.
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- Power estimation and low-power design.
- Current research in low-energy computing.
- Layout parasitics, interconnect delay, static timing analysis.
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- Electromigration, electrostatic discharge, and latch-up.
- Models of industrial cooperation in microelectronics.
- The caveats of virtual components.
- The cost structures of ASIC development and manufacturing.
- Market requirements, decision criteria, and case studies.
- Yield models.
- Avenues to low-volume fabrication.
- Marketing aspects and case studies.
- Management of VLSI projects.

Lecture notes
English lecture notes.

Literature

Prerequisites / notice
Highlight:
Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:
"VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs" or equivalent knowledge.

Further details:
http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

227-0197-00L  Wearable Systems I

Abstract
Context recognition in mobile communication systems like mobile phone and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.

Objective
Future mobile systems will act as personal and cooperative assistant by providing the appropriate information and services. The systems consist of a smart phone which communicates with sensors on-body and in the environment. Context comprises user's behavior, his activities, his local and social environment.

Content
In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

The next generation of mobile communication systems are integrated in our clothes and act as personal and cooperative assistant providing information we need just now (see www.wearable.ethz.ch). Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include
- The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Lecture notes
Language: german/english (depending on the participants)

Literature
http://www.ife.ee.ethz.ch/education/wearable_systems_1

Prerequisites / notice
No special prerequisites

227-0301-00L  Optical Communication Fundamentals

Abstract

Objective

Content

Lecture notes

Literature

Prerequisites / notice

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 465 of 1432
The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system. This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements.

An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications.

The important nonlinear optical phenomena are understood and can be classified. The effects can be described mathematically by means of the susceptibility.

Starting with an angular spectrum representation of optical fields the role of inhomogeneous evanescent fields is discussed. Among the nonlinear optical phenomena are understood and can be classified. The effects can be described mathematically by means of the susceptibility.

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Understanding concepts of light localization and light-matter interactions on the nanoscale.

Nonlinear Optics is the study of optical phenomena and techniques on the nanometer scale. It is an emerging field of study motivated by the rapid advance of nanoscience and technology. It embraces topics such as plasmonics, optical antennas, optical trapping and manipulation, and high-resolution imaging and spectroscopy.

The lectures are accompanied by weekly laboratory sessions. The important nonlinear optical phenomena are understood and can be classified. The effects can be described mathematically by means of the susceptibility.

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Starting with an angular spectrum representation of optical fields the role of inhomogeneous evanescent fields is discussed. Among the nonlinear optical phenomena are understood and can be classified. The effects can be described mathematically by means of the susceptibility.
The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. A Manuscript is distributed. Lecture Slides

Prerequisites / notice

Voraussetzungen: Physik I, II, III wünschenswert

The application of the basic methods will be extensively explained using existing and future wireless and wired systems.

Recommended Subjects

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.
The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions.

The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies. Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers.

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password.

Details: https://people.ee.ethz.ch/~haschmid/asfwiki/

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.

Prerequisites / notice
Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria ...) and of the main properties of linear systems is necessary.

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.

At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behavior of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.

227-0618-00L Modeling, Characterization and Reliability of Power Semiconductors

Objective
The students shall get acquainted with the most important concepts and techniques for characterization, numerical modeling and built-in reliability of modern power semiconductor devices. This knowledge is intended to provide the future engineer with the theoretical background and tools for the design of dependable power devices and systems.

Content
This lecture consists of a theoretical part (50%) and of laboratory exercises and demonstrations (50%).

Literature
Eiichi Ohno: "Introduction to Power Electronics"
B. Murai et al.: "Smart Power ICs"
B. J. Baliga: "Physics Modern Power Devices"
S. K. Ghadi: "Semiconductor Power Devices"

227-0620-00L Characterization of the Electronic Properties of Materials for Semiconductor Devices

Objective
The characterization of the electronic properties of semiconductor and related materials is fundamental to manufacture integrated devices, which fulfill the required specifications. By this lecture, the students shall get acquainted with the main electrical characterization techniques of the electronic properties of semiconductors and thin film materials used in microelectronics as well as with their physical principles. This knowledge is intended to provide the future engineer with the theoretical background and experimental tools for process control in semiconductor manufacturing, parameter extraction in device simulation, and design of dependable devices.

Content
This lecture consists of a theoretical part (80%) and of laboratory exercises and demonstrations (20%). In the first section of the lecture, methods and procedures are presented for the experimental characterization of relevant electronic parameters in the bare semiconductor (mainly silicon), like resistivity, carrier and doping density, contact resistance, and Schottky barriers, defect density, carrier lifetime, mobility. The second section deals with techniques involving basic structures and devices (contact chains, MIS capacitors, diodes, gated diodes, BJT, MOSFET) for the characterization of atomic transport, mechanical stress, dielectric thickness, impact ionization, channel mobility, instabilities, defect formation at interfaces and in thin film dielectrics, carrier transport and trapping in thin film dielectrics, quasi-static and dynamic device characteristics. The list of the covered methods includes among others probing, Kelvin measurements, VanderPauw technique, Hall spectroscopy, SIMS, Raman spectroscopy, spreading resistance, scanning probe techniques, static/high-speed I-V, static/high-frequency C-V, open circuit voltage decay, carrier recombination techniques, Zerbst techniques, deep level transient spectroscopy, split C-V, charge pumping, and inverse modeling techniques using TCAD. All methods are presented in conjunction with the properties of structures. During the laboratory activities, a selection of the experimental techniques discussed in the lecture are demonstrated on the base of realistic examples.

Literature
Schroeder D.K, Semiconductor Material and Device Characterization, Wiley Ed.
F. Balestra Ed., Nanoscale CMOS : innovative materials, modeling and characterization, ISTE

227-0627-00L Applied Computer Architecture

Objective
This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.

Content
The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits. Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)? Which architecture is behind the alarm center of the Swiss Railway (SBB)? Which computer architectures are applied for driver assistance systems? Which computer architecture is hidden behind a professional digital audio mixing desk? How can data volumes about 30 TB/s, produced by a proton accelerator, be processed in real time? Can the weather forecast also be processed with GPUs? How can a good computer architecture be found? Which are the driving factors in successful computer architecture design?

Literature
Script and exercises sheets.

Prerequisites / notice
Basics of computer architecture.

227-0659-00L Integrated Systems Seminar

Objective
In the "Fachseminar IIS" the students learn to communicate topics, ideas or problems of scientific research by listening to more experienced authors and by presenting scientific work in a conference-like situation for a specific audience.

Content
Attendees have the possibility to become acquainted with a current topic by a literature study, and to present the results thereof in a 20 minutes talk in English. The participation at the seminar gives also an overview on current problems in modern nano- and opto-electronics.

Literature
Presentation material

227-0707-00L Optimization Methods for Engineers

Objective
First half of the semester: Introduction to the main methods of numerical optimization with focus on stochastic methods such as genetic algorithms, evolutionary strategies, etc.

Content
Second half of the semester: Each participant implements a selected optimizer and applies it on a problem of practical interest.
Introduction to Plasmonics

This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

C. Hierold

Abstract

Since the fabrication and characterization of micro- and nanostructures is difficult, expensive, and time-consuming, numerical modelling drastically reduced the design process. Although many commercial software packages are available, it is important to know the drawbacks and difficulties of the numerical methods behind them and to be able to validate the results obtained with such packages.

First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the topics to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electrodynamics to multiphysics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

Physical Modelling and Simulation

227-2037-00L

Physical modelling plays an important role in the analysis and design of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied.

Abstract

Since the fabrication and characterization of micro- and nanostructures is difficult, expensive, and time-consuming, numerical modelling drastically reduced the design process. Although many commercial software packages are available, it is important to know the drawbacks and difficulties of the numerical methods behind them and to be able to validate the results obtained with such packages.

First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the topics to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electrodynamics to multiphysics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

The course will be taught in English.

Lecture notes

Priority 1: master students of the master's program in "Micro and Nanosystems"

Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MAYT-tutors Profs Daraio, Dual, Hierold, Krommatskas, Nelson, Norris, Park, Poulikakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 4: all other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more than 15 students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.

Autumn Semester 2015

Data: 06.12.2018 13:04

Page 470 of 1432
Objective
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

Content
Fundamentals of Plasmonics
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

Lecture notes
Class notes and handouts

Literature

Prerequisites / notice
No specific background in physics or mathematics is required.

Energy and Power Electronics

Core Subjects
These core subjects are particularly recommended for the field of "Energy and Power Electronics".

Number	Title	Type	ECTS	Hours	Lecturers
227-0247-00L	Power Electronic Systems I	W	6 credits	4G	J. W. Kolar

Abstract
Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant DC/DC converters are analyzed in detail and high frequency loss mechanisms of magnetic components are explained. Space vector modulation of three-phase inverters is introduced and the main power components are designed for typical industry applications.

Objective
Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter systems. Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion of three-phase PWM converters systems in the lecture Power Electronic Systems II.

Content
Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching losses are explained. Furthermore, zero voltage switching, zero current switching, and resonant DC/DC converters are discussed in detail; the operating behavior of isolated full-bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of three-phase inverter systems are discussed related to voltage DC link inverter systems and the design of the main power components based on analytical calculations is explained.

Lecture notes
Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

Prerequisites / notice
Prerequisites: Introductory course on power electronics.

227-0517-00L	Electrical Drive Systems II	W	6 credits	4G	P. Steimer, G. Scheuer, C. A. Stulz

Abstract
In the course "Drive System II" the power semiconductors are repeated. The creation of converters based on the combination of switches/cells and based topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions. Further topics are the control of the synchronous machine, of line-side converters and issues with converter-fed machines.

Objective
The students establish a deeper understanding in regards of the design of the main components of an electrical drive system. They establish knowledge on the most important interaction with the grid and the machine and their related high dynamic control.

Content
Converter topologies (switch or cell based), multi-pulse diode rectifiers, system aspects of transformer and electrical machines, 3-level inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent magnet machines), control of line-side converters, reflection effects with power cables, winding isolation and bearing stress. Field trip to ABB Semiconductors.

Lecture notes
Skript is sold at the beginning of the lectures or can be downloaded from Ilias.
### 227-0526-00L  
**Power System Analysis**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>4G</th>
<th>G. Andersson</th>
</tr>
</thead>
</table>

**Abstract**
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

**Objective**
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

**Content**
The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

**Lecture notes**
Lecture notes. Course is supported by WWW-teaching system.

### 227-0567-00L  
**Design of Power Electronic Systems**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>4G</th>
<th>F. Krismern</th>
</tr>
</thead>
</table>

**Abstract**
Complete design process: from given specifications to a complete power electronic system; selection / design of suitable passive power components; static and dynamic properties of power semiconductors; optimized EMI filter design; heat sink optimization; additional circuitry, e.g. gate driver; system optimization.

**Objective**
Basic knowledge of design and optimization of a power electronic system; furthermore, lecture and exercises thoroughly discuss key subjects of power electronics that are important with respect to a practical realization, e.g. how to select suitable power components, how to determine switching losses, calculation of high frequency losses, EMI filter design and realization, thermal considerations.

**Content**
Complete design process: from given specifications to a complete power electronic system.
Selection and / or design of suitable passive power components: specific properties, parasitic components, tolerances, high frequency losses, thermal considerations, reliability. Static and dynamic characteristics of power semiconductors. Optimized design of the EMI filter. Thermal characterization of the converter, optimized heat sink design. Additional circuitry: gate driver, measurement, control. Converter start up: typical sequence of events, circuitry required. Overall system optimization; identifying couplings between different components of the considered power electronic system, optimization targets and issues.

**Lecture notes**
Lecture notes and complementary exercises including correct answers.

### 227-0731-00L  
**Power Market I - Portfolio and Risk Management**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>4G</th>
<th>D. Reichelt, G. A. Koeppl</th>
</tr>
</thead>
</table>

**Abstract**
Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model, strategy development and positioning.

**Objective**

**Content**
1. Pan-European power market and trading
   1.1. Power trading
   1.2. Development of the European power markets
   1.3. Energy economics
   1.4. Spot and OTC trading
   1.5. European energy exchange EEX
2. Market model
   2.1. Market place and organisation
   2.2. Balance groups / balancing energy
   2.3. Ancillary services
   2.4. Market for ancillary services
   2.5. Cross-border trading
   2.6. Capacity auctions
3. Portfolio and Risk management
   3.1. Portfolio management 1 (introduction)
   3.2. Forward and futures contracts
   3.3. Risk management 1 (m2m, VaR, hpfc, volatility, cVaR)
   3.4. Risk management 2 (PaR)
   3.5. Contract valuation (HPFC)
   3.6. Portfolio management 2
   2.8. Risk Management 3 (enterprise wide)
4. Energy & Finance I
   4.1. Options 1 basics
   4.2. Options 2 hedging with options
   4.3. Introduction to derivatives (swaps, cap, floor, collar)
   4.4. Financial modelling of physical assets
   4.5. Trading and hydro power
   4.6. Incentive regulation
5. Strategy
   5.1. Strategic Positioning
   5.2. Development of strategies and examples
   5.3. Cases for team work

**Lecture notes**
Handouts of the lecture

**Prerequisites / notice**
1 excursion per semester, 2 case studies, guest speakers for specific topics
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, KMS algorithm, Viterbi algorithm.

Objective
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are "linearity" and "probability". In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the Viterbi algorithm, and the Viterbi algorithm.

Content
Discrete-time linear systems and the z-transform.
Discrete time and continuous time: forth and back.
Digital filters.
DFT.
Elements of probability theory.
Discrete-time stochastic processes.
Elements of detection theory and estimation theory.
Linear estimation and filtering.
Wiener filter.
LMS algorithm.
Viterbi algorithm.

Abstract
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, KMS algorithm, Viterbi algorithm.

Objective
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are "linearity" and "probability". In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the KMS algorithm, and the Viterbi algorithm.

Content
Discrete-time linear systems and the z-transform.
Discrete time and continuous time: forth and back.
Digital filters.
DFT.
Elements of probability theory.
Discrete-time stochastic processes.
Elements of detection theory and estimation theory.
Linear estimation and filtering.
Wiener filter.
LMS algorithm.
Viterbi algorithm.

Lecture notes
Lecture Slides.

Literature

The application of the basic methods will be extensively explained using existing and future wireless and wired systems.

Objective
To provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

Content
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

Prerequisites / notice
Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.

Abstract
The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

Objective
By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.

Content
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

Prerequisites / notice
Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.

Abstract
Basic characteristics of railway vehicles and their interfaces with the railway infrastructure:
- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signalling systems
- Traffic control and maintenance

Objective
- Overview of the technical characteristics of railway systems
- Knowledge about the design and construction principles of rail vehicles
- Interrelation between different fields of engineering sciences (mechanics, electro and information technology, transport systems)
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Motivation of young engineers to start a career in the railway industry or with railway operators
227-0618-00L   Modeling, Characterization and Reliability of Power Semiconductors

This lecture provides theoretical and experimental knowledge on the techniques for the characterization and numerical modeling of power semiconductor devices, as well as on the related built-in reliability strategies.

227-0697-00L   Industrial Process Control

Introduction to process automation and its application in process industry and power generation

227-0707-00L   Optimization Methods for Engineers

First half of the semester: Introduction to the main methods of numerical optimization with focus on stochastic methods such as genetic algorithms, evolutionary strategies, etc.

Second half of the semester: Each participant implements a selected optimizer and applies it on a problem of practical interest.
### Systems and Control

#### Core Subjects

**These core subjects are particularly recommended for the field of “Systems and Control”.**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0225-00L</td>
<td>Linear System Theory</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>J. Lygeros, M. Kamgarpour</td>
</tr>
<tr>
<td>227-0697-00L</td>
<td>Industrial Process Control</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>G. Maier, A. Horch</td>
</tr>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>R. D’Andrea</td>
</tr>
</tbody>
</table>

#### Prerequisites / notice

- **Lecture notes**
- **Prerequisites / notice**

The lecture will be held in three blocks each of them on a Saturday. Each block will focus on one of the three main topics of the course. Between the blocks the students will work on specific case studies to deepen the subject matter. About two weeks after the third block a written examination will be conducted.

#### Literature

- **Prerequisites:** Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.
- **Lecture notes:** PDF file see http://alphard.ethz.ch/hafner/Vorles/lect.htm
- **Content:** Introduction to Dynamic Programming and Optimal Control.
- **Objective:** Covers the fundamental concepts of Dynamic Programming & Optimal Control.
- **Abstract:** Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

**Dynamic Programming and Optimal Control**

- **Industrial Process Control:** Introduction to process automation and its application in process industry and power generation
- **Objective:** Knowledge of process automation and its application in industry and power generation
- **Content:** Analysis and design of open loop control problems: discrete automata, petri-nets, decision tables, drive control and object oriented function group automation philosophy, RT-UMI; Engineering: Application programming in IEC61131-3 (function blocks, sequence control, structured text); Process visualization and operation; engineering integration from sensor, cabling, topology design, function, visualization, diagnosis, to documentation; Industry standards (e.g. OPC, Profbus);
- **Exercises:** Slides will be available as .PDF documents, see "Learning materials" (for registered students only)
- **Prerequisites / notice:** Practical examples from process industry, power generation and newspaper production.

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Data: 06.12.2018 13:04
Autumn Semester 2015
Page 475 of 1432
Discrete Event Systems

Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study systems governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

Prerequisites:
Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

Recommended Subjects

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0102-00L</td>
<td>Discrete Event Systems</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>L. Thiele, L. Vanbever, R. Wattenhofer</td>
</tr>
</tbody>
</table>

Abstract
Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective
Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

Content
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes
Available

Literature
[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[sipser] Introduction to the Theory of Computation
Michael Sipser

Image Analysis and Computer Vision


Objective
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose.

Content
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining owns experience through practical computer and programming exercises.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites /
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

Power System Analysis

Number 227-0447-00L
Type W
ECTS 6
Hours 3V+1U
Lecturers G. Székely
Prerequisites: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

Number 227-0526-00L
Type W
ECTS 6
Hours 4G
Lecturers G. Andersson
Prerequisites: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Scripts of all lectures will be available. The handouts in English will be sold in the first lecture. A list of references is included in the handouts.

### Lecture notes
Lecture notes. Course is supported by WWW-teaching system.

#### 227-0689-00L System Identification

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>2V+1U</th>
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<tr>
<td>R. Smith</td>
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</table>

#### Abstract
Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data.

#### Objective
To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity.

#### Content
Identification of systems: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models.

Predictive, open-loop, black-box identification methods. Time and frequency domain methods. Subspace identification methods.

Optimal experimental design, Cramer-Rao bounds, input signal design.

Parametric identification methods. On-line and batch approaches.

#### Literature


#### Prerequisites / notice
Control systems (227-0216-00L) or equivalent.

#### Literature
Metaheuristics for large scale optimization problems. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

#### 151-0104-00L Uncertainty Quantification for Engineering & Life Sciences

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<tr>
<th>W</th>
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<tr>
<td>J. Beck, P. Koumoutsakos</td>
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</table>

#### Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

#### Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

#### Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

#### Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

#### Literature
151-0473-00L Theory of Robotics and Mechatronics

<table>
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<tr>
<th>W</th>
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<tbody>
<tr>
<td>P. Korba, S. Stoeter, B. Nelson</td>
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</tbody>
</table>

#### Abstract
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

#### Objective
Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data.

Examples: mechatronic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Planning of experiments, estimation techniques for "gray-box" models (linear and nonlinear least-squares methods). The exercises are solved in teams. One larger case study is to be solved.

The handouts in English will be sold in the first lecture.

A list of references is included in the handouts.
This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

The course will be taught in English.


Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

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**Literature**

**Introductory Books:**


**Selected Journal Articles and Web Links:**

- VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

**Prerequisites / notice**

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

**401-0647-00L Introduction to Mathematical Optimization**

**Abstract**

Introduction to basic techniques and problems of mathematical optimization.

**Objective**

The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

**Content**

- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

**Literature**

Information about relevant literature will be given in the lecture.

**Prerequisites / notice**

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

**401-3901-00L Mathematical Optimization**

**Abstract**

Mathematical treatment of diverse optimization techniques.

**Objective**

Advanced optimization theory and algorithms.

1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas’ Lemma and infeasibility certificates, duality theory of linear programming.
3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.
4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

**Prerequisites / notice**

This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.
Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a comprehensive copy of transparencies

The course consists of lectures and exercises. Didactical concept: "Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

Abstract

Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.

Content

Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality

Lecture notes

The handout is available in German and English.

Prerequisites / notice

"Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

Didactical concept:
The course consists of lectures and exercises.

Subjects of General Interest

Number Title Type ECTS Hours Lecturers

227-0377-00L Physics of Failure and Failure Analysis of Electronic Devices and Equipment W 3 credits 2V U. Sennhauser

Abstract

Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

Objective

Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

Content

Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis

Lecture notes

Comprehensive copy of transparencies

363-0790-00L Technology Entrepreneurship W 2 credits 2V U. Claesson, P. Baschera, F. Hacklin

Abstract

Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

Objective

This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

Content

See course website

Lecture notes

Lecture slides and case material

151-0317-00L Computational Systems Biology W 6 credits 3V+2U J. Stelling

Abstract

Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective

The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content

Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Literature


Semester Projects

Number Title Type ECTS Hours Lecturers

227-1101-00L How to Write Scientific Texts in Engineering Sciences E- Strongly recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EIT, MSc EST). W 0 credits J. Leuthold

Abstract

The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Objective

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.
Content

* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

Literature

ETH “Citation Etiquette”, see www.plagiate.ethz.ch.


Prerequisites / notice

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1500-00L</td>
<td>Internship in Industry Only for Electrical Engineering and Information Technology MSc.</td>
<td>Z</td>
<td>0</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

Objective

see above

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1501-00L</td>
<td>Master's Thesis ■ Admission only if A L L of the following apply: a) bachelor program successfully completed; b) acquired (if applicable) all credits from additional requirements for admission to master program; c) successfully completed both semester projects. Note: the conditions above are not applicable to incoming exchange students.</td>
<td>O</td>
<td>30</td>
<td>68D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Autumn Semester 2015
Registration in myStudies required!

The Master Program finishes with a 6-months Master Thesis which is directed by a Professor of the Department or a Professor of another Department who is associated with the D-ITET. Students gain the ability to conduct independent scientific research on a specific research problem.

Objective

see above

**Generally Accessible Seminars and Colloquia**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0919-00L</td>
<td>Knowledge-Based Image Interpretation</td>
<td>Z</td>
<td>0</td>
<td>2S</td>
<td>G. Székely, L. Van Gool</td>
</tr>
<tr>
<td>Abstract</td>
<td>With the lecture series on special topics of Knowledge based image interpretation we sporadically offer special talks. To become acquainted with selected, recent results in image analysis and interpretation.</td>
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<tr>
<td>Objective</td>
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<tr>
<td>227-0920-00L</td>
<td>Seminar in Systems and Control</td>
<td>Z</td>
<td>0</td>
<td>1S</td>
<td>F. Dörfler, R. D'Andrea, J. Lygeros, R. Smith</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current topics in Systems and Control presented mostly by external speakers from academia and industry</td>
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<td>Objective</td>
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<tr>
<td>227-0955-00L</td>
<td>Seminar in Electromagnetics</td>
<td>Z</td>
<td>3</td>
<td>2K</td>
<td>J. Leuthold</td>
</tr>
<tr>
<td>Abstract</td>
<td>Selected topics of the current research activities of the IFH and closely related institutions are discussed. Have an overview on the research activities of the IFH.</td>
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<tr>
<td>Objective</td>
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<tr>
<td>227-0950-00L</td>
<td>Acoustics</td>
<td>Z</td>
<td>0</td>
<td>0.5K</td>
<td>K. Heutschi</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current topics in Acoustics presented mostly by external speakers from academia and industry</td>
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<tr>
<td>Objective</td>
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</tr>
<tr>
<td>227-0970-00L</td>
<td>Research Topics in Biomedical Engineering</td>
<td>Z</td>
<td>0</td>
<td>2K</td>
<td>M. Rudin, S. Kozerke, K. P. Prüssmann, M. Stampanoni, K. E. Stephan, J. Vörös</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current topics in Biomedical Engineering presented by speakers from academia and industry.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Getting insight into actual areas and problems of Biomedical Engineering an Health Care.</td>
<td></td>
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</tr>
<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>Z</td>
<td>0</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Actual developments and problems of magnetic resonance imaging (MRI)</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Getting insight to advanced topics in Magnetic Resonance Imaging</td>
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</tbody>
</table>

**Course Units for Additional Admission Requirements**

The courses below are only available for MSc students with additional requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0101-AAL</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>E-</td>
<td>6</td>
<td>8R</td>
<td>H.A. Loeliger</td>
</tr>
</tbody>
</table>
| Abstract   | Enrollment only for MSc students who need this course as additional admission requirement.  
Fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm. |
| Objective  | Through self study the participant is introduced to some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are "linearity" and "probability". In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm. |
| Content    | Discrete-time linear systems and the z-transform.  
Discrete time and continuous time: forth and back.  
Digital filters.  
DFT.  
Elements of probability theory.  
Discrete-time stochastic processes.  
Elements of detection theory and estimation theory.  
Linear estimation and filtering.  
Wiener filter.  
LMS algorithm.  
Viterbi algorithm. |
| Lecture notes | Lecture Notes.                           |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0103-AAL</td>
<td>Control Systems</td>
<td>E-</td>
<td>6</td>
<td>8R</td>
<td>M. Morari, F. Dörfler</td>
</tr>
</tbody>
</table>
| Abstract   | Enrollment only for MSc students who need this course as additional admission requirement.  
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems. |
| Objective  | Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems. |
| Lecture notes | Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF). |

**Prerequisites / notice**

Prerequisites: Signal and Systems Theory II.
MATLAB is used for system analysis and simulation.

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0166-AAL</td>
<td>Analog Integrated Circuits</td>
<td>E-</td>
<td>6</td>
<td>8R</td>
<td>Q. Huang</td>
</tr>
</tbody>
</table>

*Enrolment only for MSc students who need this course as additional admission requirement.*

**Course offered only in the autumn semester with an examination only in winter.**

**Abstract**

This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

**Objective**

Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems. The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

**Content**

Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active loads, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.

**Lecture notes**

Handouts of slides. No script but an accompanying textbook is recommended.

**Literature**


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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0117-AAL</td>
<td>High Voltage Technology</td>
<td>E-</td>
<td>6</td>
<td>8R</td>
<td>C. Franck</td>
</tr>
</tbody>
</table>

*Enrolment only for MSc students who need this course as additional admission requirement.*

**Abstract**

Understanding of the fundamental phenomena and principles connected with the occurrence of extensive electric field strengths. This knowledge is applied to the dimensioning of high-voltage equipment. Methods of computer-modeling in use today are presented and applied within a workshop in the framework of the exercises.

**Objective**

The students know the fundamental phenomena and principles connected with the occurrence of extensive electric field strengths. They comprehend the different mechanisms leading to the failure of insulation systems and are able to apply failure criteria on the dimensioning of high voltage components. They have the ability to identify of weak spots in insulation systems and to name possibilities for improvement. Further they know the different insulation systems and their dimensioning in practice.

**Content**

- discussion of the field equations relevant for high voltage engineering.
- analytical and numerical solutions/solving of this equations, as well as the derivation of the important equivalent circuits for the description of the fields and losses in insulations
- introduction to kinetic theory of gases
- mechanisms of the breakdown in gaseous, liquid and solid insulations, as well as insulation systems
- methods for the mathematical determination of the electric withstand of gaseous, liquid and solid insulations
- application of the expertise on high voltage components
- excursion to manufacturers of high voltage components
- exercise to learn on computer-modeling in high voltage engineering

**Lecture notes**

Handouts

**Literature**


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**Electrical Engineering and Information Technology Master - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>Type</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Energy Science and Technology Master

Core Subjects

Compulsory core courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1633-00L</td>
<td>Energy Conversion</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>H. G. Park</td>
</tr>
<tr>
<td></td>
<td>Fundamentals of Thermal Sciences in association with Energy Conversion</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>To become acquainted and familiarized with basic principles of fundamental thermal sciences (Thermodynamics, Heat Transfer, etc.) as well as their linkage to energy conversion technologies.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications</td>
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<tr>
<td></td>
<td>Slides will be distributed by e-mail every week.</td>
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</tr>
<tr>
<td></td>
<td>1. Introduction to Thermodynamics and Heat Transfer, 2nd ed. by Cengel, Y. A., McGraw Hill;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Fundamentals of Engineering Thermodynamics, 6th ed. by Moran &amp; Shapiro, Wiley</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>This course is intended for students outside of D-MAVT.</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0122-00L</td>
<td>Introduction to Electric Power Transmission: System &amp; Technology</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>C. Franck, G. Hug</td>
</tr>
<tr>
<td></td>
<td>Introduction to theory and technology of electric power systems.</td>
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<tr>
<td></td>
<td>At the end of this course, the student will be able to: describe the structure of electric power systems, name the most important components and describe what they are needed for, apply models for transformers and lines, explain the technology of power lines and switchgear, calculate stationary power flows and other basic parameters in simple power systems.</td>
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</tr>
<tr>
<td></td>
<td>Structure of electric power systems, transformer and power line models, analysis of and power flow calculation in basic systems, symmetrical and unsymmetrical three-phase systems, transient current and voltage processes, technology and principle of electric power systems, HVDC and FACTS.</td>
<td></td>
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<tr>
<td></td>
<td>Lecture script in English, exercises and sample solutions, translation of important vocabulary: english-german.</td>
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</tbody>
</table>

Elective Core Courses

These courses are particularly recommended, other ETH-courses from the field of Energy Science and Technology at large may be chosen in accordance with your tutor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0577-00L</td>
<td>An Introduction to Sustainable Development in the Built Environment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Habert</td>
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<tr>
<td></td>
<td>This course was offered as &quot;Sustainable Construction&quot; until HS14.</td>
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<td></td>
<td>This year the UN Conference in Paris will shape future world objectives to tackle climate change.</td>
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<td></td>
<td>This course provides an introduction to the notion of sustainable development when applied to our built environment.</td>
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<td></td>
<td>At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.</td>
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<td></td>
<td>In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).</td>
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<td></td>
<td>For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmental aspects.</td>
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<td></td>
<td>The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.</td>
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<td>Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.</td>
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<td>After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.</td>
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<td>The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.</td>
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<td>The following topics give an overview of the themes that are to be worked on during the lecture.</td>
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<td></td>
<td>- Overview on the history and emergence of sustainable development</td>
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<tr>
<td></td>
<td>- Overview on the current understanding and definition of sustainable development</td>
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<td>- Case Study 1: Sustainable construction, the role of construction industry (national/international)</td>
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<td>- Case Study 2: Cities, forms of settlements</td>
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<td>- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism</td>
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<td>- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations</td>
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<td>- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)</td>
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<td>- Method 2: Economics for sustainable construction</td>
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<td>- Method 3: Construction, flexibility, modularity</td>
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<td></td>
<td>- Synthesis 1: Climate Change mitigation and adaptation in cities</td>
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<td>- Synthesis 2: Transition to sustainable development</td>
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<td></td>
<td>All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.</td>
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<td>A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.</td>
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<tr>
<td>Course Code</td>
<td>Title</td>
<td>Credits</td>
<td>Prerequisites</td>
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<tr>
<td>151-0163-00L</td>
<td>Nuclear Energy Conversion</td>
<td>4</td>
<td>W, 2V+1U, H.M. Prasser</td>
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<tr>
<td>151-0185-00L</td>
<td>Radiation Heat Transfer</td>
<td>4</td>
<td>W, 2V+1U, A. Steinfeld, A. Z'Graggen</td>
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<tr>
<td>151-0203-00L</td>
<td>Turbomachinery Design</td>
<td>4</td>
<td>W, 2V+1U, R. S. Abhari, N. Chokani, B. Ribi</td>
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<tr>
<td>151-0207-00L</td>
<td>Theory and Modeling of Reactive Flows</td>
<td>4</td>
<td>3G, C. E. Frouzakis, I. Mantzaras</td>
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</tbody>
</table>

**Abstract**

The course presents an overview of measurement tasks in engineering environments. Different concepts for the acquisition and processing of typical measurement quantities are introduced. Following an initial in-class introduction, laboratory exercises from different application areas (especially in thermofluidics and process engineering) are attended by students in small groups.

**Objective**

Introduction to various aspects of measurement techniques, with particular emphasis on thermo-fluidic applications. Understanding of various sensing technologies and analysis procedures.

**Content**

In-class introduction to representative measurement techniques in the research areas of the participating institutes (fluid dynamics, energy technology, process engineering)

**Student participation**

8-10 laboratory experiments (study groups of 3-5 students, dependent on the number of course participants and available experiments)

**Lab reports**

For all attended experiments have to be submitted by the study groups.

**Literature**


**Prerequisites / notice**

- Fluid mechanics, thermodynamics, heat and mass transfer
- Electrical engineering / electronics
- Numerical data analysis and processing (e.g. using MATLAB)

**Handouts**

Presentations, handouts and instructions are provided for each experiment.

**Lecture notes**

Additional material and information on the website of the lab:


**Handouts**

Handouts will be distributed. Additional literature and information on the website of the lab:

Dieter Smidt: Reaktortechnik, Band 1 und Band 2, G. Braun Karlsruhe, 1971

**Objective**

Students get an overview on energy conversion in nuclear power plants, on construction and function of the most important types of nuclear reactors and power plants, light water reactors and other reactor types, conversion and breeding

**Content**

Nuclear physics of fission and chain reaction. Therdodynamics of nuclear reactors. Design of the rector core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, difference between thermal reactors and fast breeders. Construction and operation of nuclear power reactors with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion, Development tendencies of rector technology.

**Literature**


**Objective**

Introduction to the understanding of a broad range of turbomachinery devices. Learn the steps of turbomachinery design.

**Content**

Understanding the principles, and learn the design procedures and the behaviour of turbomachines.

**Literature**


**Objective**

The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

**Content**

Theory of combustion with numerical applications

**Literature**

H.M. Prasser, A. Steinfeld, A. Z'Graggen

H. M. Prasser, A. Steinfeld, H. M. Prasser, A. Steinfeld, A. Z'Graggen
Prerequisites / notice

**151-0216-00L** Wind Energy

**Objective**
The objective of this course is to introduce the students to the fundamentals, technologies, modern day application, and economics of wind energy. These subjects are introduced through a discussion of the basic principles of wind energy generation and conversion, and a detailed description of the broad range of relevant technical, economic and environmental topics.

**Content**
This mechanical engineering course focuses on the technical aspects of wind turbines; non-technical issues are not within the scope of this technically oriented course. On completion of this course, the student shall be able to conduct the preliminary aerodynamic and structural design of the wind turbine blades. The student shall also be more aware of the broad context of drivetrains, dynamics and control, electrical systems, and meteorology, relevant to all types of wind turbines.

**151-0251-00L** IC-Engines and Propulsion Systems I

**Objective**
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials.

**Content**
Introduction to basic concepts, operating maps and work processes of internal combustion engines. Thermodynamic analysis and design, scavenging methods, heat transfer mechanisms, turbulent flow field in combustion chambers, turbocharging. Energy systemic role of IC engines: conventional and electrified vehicle propulsion systems and decentralized power generation.

**Literature**

**151-0293-00L** Combustion and Reactive Processes in Energy and Materials Technology

**Objective**
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The lecture is part of the focus "Energy, Flows & Processes" on the Bachelor level and is recommended as a basis for a future Master in the area of energy. It is also a facultative lecture on Master level in Energy Science and Technology and Process Engineering.

**Content**

**Literature**

**151-0567-00L** Engine Systems

**Objective**
Introduction to current and future engine systems and their control systems. Application to real engines. Understand the structure and behavior of drive train systems and their quantitative descriptions.

**Content**
Physical description and mathematical models of components and subsystems (mixture formation, load control, supercharging, emissions, drive train components, etc.). Case studies of model-based optimal design and control of engine systems with the goal of minimizing fuel consumption and emissions.

**Literature**

**151-0569-00L** Vehicle Propulsion Systems

**Objective**
Introduction to current and future propulsion systems and the electronic control of their longitudinal behavior.

**Content**
Understanding of physical phenomena and mathematical models of components and subsystems (manifold, automatic and continuously variable transmissions, energy storage systems, electric drive trains, batteries, hybrid systems, fuel cells, road/wheel interaction, automatic braking systems, etc.). Presentation of mathematical methods, CAE tools and case studies for the model-based design and control of propulsion systems with the goal of minimizing fuel consumption and emissions.

**Literature**

**227-0247-00L** Power Electronic Systems I

**Objective**
Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant DC/DC converters are analyzed in detail and high frequency loss mechanisms of magnetic components are explained. Space vector modulation of three-phase inverters is introduced and the main power components are designed for typical industry applications.

**Content**
Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter systems. Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion of three-phase PWM converters systems in the lecture Power Electronic Systems II.
Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching losses are explained. Furthermore, zero voltage switching, zero current switching, and resonant DC/DC converters are discussed in detail.

The operating behavior of isolated full-bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of three-phase inverter systems are discussed related to voltage DC link inverter systems and the design of the main power components based on analytical calculations is explained.

The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand ancillary services, balancing power market, Swiss market model, strategy development and positioning.

Prerequisites: Introductory course on power electronics.

The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the design and construction principles of rail vehicles.

- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signaling systems
- Traffic control and maintenance

Overview of the technical characteristics of railway systems

- Know-how about the design and construction principles of rail vehicles
- Interrelationship between different fields of engineering sciences (mechanics, electro and information technology, transport systems)
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Motivation of young engineers to start a career in the railway industry or with railway operators

Content

EST I (Frühjahrssemester) - Begriffe, Grundlagen, Merkmale

1. Einführung:
   1.1 Geschichte und Struktur des Bahnsystems
   1.2 Fahrdynamik

2. Vollbahnfahrzeuge:
   2.1 Mechanik: Kasten, Drehgestelle, Lautechnik, Adhäsion
   2.2 Bremsen
   2.3 Traktionsantriebssysteme
   2.4 Hilfsbetriebe und Komfortanlagen
   2.5 Steuerung und Regelung

3. Infrastruktur:
   3.1 Fahrweg
   3.2 Bahnstromversorgung
   3.3 Sicherungsanlagen

4. Betrieb:
   4.1 Interoperabilität, Normen und Zulassung
   4.2 RAMS, LCC
   4.3 Anwendungsbeispiele

Voraussichtlich ein oder zwei Gastvorträge

Voraussichtlich ein oder zwei Gastvorträge von anderen Referenten.

Geplante Exkursionen:
- Betriebszentrale SBB, Zürich Flughafen
- Betriebszentrale SBB, Zürich Altstetten
- Fahrzeugfertigung, Stadtler Bussnang

Lecture notes

Abgabe der Unterlagen (gegen eine Schutzgebühr) zu Beginn des Semesters. Rechtzeitig eingeschriebene Teilnehmer können die Unterlagen auf Wunsch und gegen eine Zusatzgebühr auch in Farbe beziehen.

Prerequisites / notice

Dozent:
Dr. Markus Meyer, Emkamatik GmbH

The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

Content

Power market I - Portfolio and Risk Management

Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model, strategy development and positioning.
Objective

Content
1. Pan-European power market and trading
   1.1. Power trading
   1.2. Development of the European power markets
   1.3. Energy economics
   1.4. Spot and OTC trading
   1.5. European energy exchange EEX

2. Market model
   2.1. Market place and organisation
   2.2. Balance groups / balancing energy
   2.3. Ancillary services
   2.4. Market for ancillary services
   2.5. Cross-border trading
   2.6. Capacity auctions

3. Portfolio and Risk management
   3.1. Portfolio management 1 (introduction)
   3.2. Forward and futures contracts
   3.3. Risk management 1 (m2m, VaR, hpfc, volatility, cVaR)
   3.4. Risk management 2 (PaR)
   3.5. Contract valuation (HPFC)
   3.6. Portfolio management 2
   2.8. Risk Management 3 (enterprise wide)

4. Energy & Finance I
   4.1. Options 1 basics
   4.2. Options 2 hedging with options
   4.3. Introduction to derivatives (swaps, cap, floor, collar)
   4.4. Financial modelling of physical assets
   4.5. Trading and hydro power
   4.6. Incentive regulation

5. Strategy
   5.1. Strategic Positioning
   5.2. Development of strategies and examples
   5.3. Cases for team work

Prerequisites / notice
1 excursion per semester, 2 case studies, guest speakers for specific topics

227-0759-00L International Business Management for Engineers
Objective
Globalization of markets increases global competition and requires enterprises to continuously improve their performance to sustainably survive. Engineers substantially contribute to the success of an enterprise provided they understand and follow fundamental international market forces, economic basics and operational business management.

Content
The goal of the lecture is to get a basic understanding of international market mechanisms and their consequences for a successful enterprise. Students will learn by practical examples how to analyze international markets, competition as well as customer needs and how to convert into a successful portfolio an enterprise offers to the global market. They will understand the basics of international business management, why efficient organizations and effective business processes are crucial for the successful survival of an enterprise and how all this can be implemented.

Lecture notes
Handouts of the lecture

529-0193-00L Renewable Energy Technologies I
Objective
The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Content
Scenarios for the development of world primary energy consumption, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Lecture notes
Lecture notes will be distributed during the course.

Literature
Procedures for the Analysis of Structures  
Lecturers: A. E. Braunschweig, R. Frischknecht, S. Pfister, R. Frischknecht  

Objectives and Content  
Title: Advanced Environmental, Social and Economic Assessments  
Type: W  
ECTS: 6  
Hours: 3G+2U+2P  
Lecturers: A. E. Braunschweig, S. Hellweg, G. Kress  

This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.

In particular, students completing the course should have the ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors.

Knowledge about the current state of the scientific discussion and new research developments.

Ability to properly plan, conduct and interpret environmental assessment studies.

In the course element "Implementation of...", students will learn to:
- Describe key sustainability problems of the current economic system and measuring units.
- Describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- Discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance).
- Explain the pros and cons of single score env. assessment methods.
- Demonstrate life cycle costing from a sustainability viewpoint.
- Interpret stakeholder relations of an organisation.
- (If time allows) describe sustainable supply chain management.

Content:  
Part I (Advanced Environmental Assessments):  
- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties  
- Software tools (MFA, LCA)  
- Allocation (multioptput processes and recycling)  
- Hybrid LCA methods.  
- Consequential and marginal analysis  
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity  
- Spatial differentiation in Life Cycle Assessment  
- Workplace and indoor exposure in Risk and Life Cycle Assessment  
- Subjectivity in environmental assessments  
- Case Studies  

Part II (Implementation of Environmental and other Sustainability Goals):  
- Sustainability problems of the current economic system and its measuring units;  
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;  
- Sustainability Opportunities and Innovation  
- The concept of 'Continuous Improvement'  
- Life Cycle Costing, Life Cycle Management  
- Environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance), based on practical examples of companies and new concepts  
- Single score env. assessment methods (Swiss ecopoints)  
- Stakeholder management and sustainability oriented communication  
- An intro into sustainability issues of supply chain management  

Students will get small exercises related to course issues.

Lecture notes:  
Part I: (-)  
Part II: Documents will be available on Ilias  
Part III Lab: (-)

Prerequisites / notice:  
Will be made available in class.

This course should only be elected by students of environmental engineering with the Major in ESD, Air Quality Control and Waste Management. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Baumann & Tillman, The Hitchhiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications, Studentlitteratur, Lund, 2004).
| Objective | Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models. |
| Content | Anisotrope Elastizität, Linear elastisches und linearkviskoses Stoßverhalten, Viskoelastizität, mikro-makro Modellierung, Laminatetheorie, Plastizität, Visco plastizität, Beispiele aus der Ingenieuranwendung, Vergleich mit Experimenten. |
| Lecture notes | yes |
| **151-0573-00L** | **System Modeling** | W | 4 credits | 2V+2U | G. Ducard, C. Onder |
| Objective | Introduction to system modeling for control. Analysis and optimization of linear and nonlinear systems. Parameter identification. Case studies. |
| Content | Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data. Examples: mechatronic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Planning of experiments, estimation techniques for “gray-box” models (linear and nonlinear least-squares methods). The exercises are solved in teams. One larger case study is to be solved. |
| Lecture notes | A list of references is included in the handouts. |
| Literature | The handouts in English will be sold in the first lecture. |
| **151-0593-00L** | **Embedded Control Systems** | W | 4 credits | 6G | J. S. Freudenberg, M. Schmid Daners |
| Abstract | This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device. |
| Objective | Familiarize students with main architectural principles and concepts of embedded control systems. |
| Content | An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch. Subjects covered in lectures and practical lab exercises include: - The application of C-programming on a microprocessor - Digital I/O and serial communication - Quadrature decoding for wheel position sensing - Queued analog-to-digital conversion to interface with the analog world - Pulse width modulation - Timer interrupts to create sampling time intervals - System dynamics and virtual worlds with haptic feedback - Introduction to rapid prototyping |
| Prerequisites / notice | Lecture notes, lab instructions, supplemental material |
| Prerequisite courses | Control Systems I and Informatics I. |
| Notice | This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: schmid@idsc.mavt.ethz.ch) After your reservation has been confirmed please register online at www.mystudies.ethz.ch. |
| Detailed information can be found on the course website | http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html |
| **151-0927-00L** | **Rate-Controlled Separations in Fine Chemistry** | W | 4 credits | 3G | M. Mazzotti |
| Abstract | The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology. |
| Objective | The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology. |
| Content | The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystalization and precipitation. |
| Lecture notes | Handouts during the class |
| Literature | Recommendations for text books will be covered in the class |
| Prerequisites / notice | Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00) |
| **151-0951-00L** | **Process Design and Safety** | W | 4 credits | 2V+1U | P. Rudolf von Rohr |
| Abstract | Process design and safety deals with the fundamentals of process apparatus, plant design and safety. The goal of the lecture is to expound design characteristics of systems for process engineering applications. |
| Objective | Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry |
| Content | Script is available, English slides will be distributed |
| **363-0387-00L** | **Corporate Sustainability** | W | 3 credits | 2G | V. Hoffmann |
| Abstract | We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and offer e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a group project, focusing on one of the four sustainability challenges of water, energy, mobility, and food. |
| Objective | Develop critical thinking skills that are useful for corporate sustainability (argumentation, communication, evaluative judgment) |
| Be able to recognize and realize opportunities for corporate sustainability in a business environment |

Overview of the grand sustainability challenges of Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for corporate strategy, marketing & leadership, technology & innovation, and financial markets.

Critical thinking skills for corporate sustainability

In-depth case study of concrete corporate sustainability challenge in the group project phase, such as: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze radical innovations for sustainability? How to invest money in a sustainable way?

Lecture notes
Presentation slides will be distributed prior to lectures.

Literature
Literature recommendations will be distributed during the lecture.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>G</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0537-00L</td>
<td>Resource and Environmental Economics</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
</tr>
</tbody>
</table>

Abstract
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>G</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0613-00L</td>
<td>Process Simulation and Flowsheeting</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
</tr>
</tbody>
</table>

Abstract
This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies. Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems.

Objective
This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:
- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modeling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.
Overview of process simulation and flowsheeting
- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

Process modeling
- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

Process simulation
- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

Commercial software for simulation: Aspen Plus
- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging

An exemplary literature list is provided below:

A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3505-00L</td>
<td>Mineral Resources</td>
<td>3</td>
<td>V</td>
<td>C. A. Heinrich, R. Kundig, W. Leu, F. Schenker</td>
</tr>
</tbody>
</table>

Overview of the geological formation processes and the global distribution of mineral resources (metals, energy resources, bulk materials and industrial minerals), their economic importance, as well as the political and environmental aspects of responsible resource extraction and site rehabilitation.


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0963-00L</td>
<td>Energy and Mobility</td>
<td>3</td>
<td>G</td>
<td>P. J. de Haan van der Weg, M. Müller</td>
</tr>
</tbody>
</table>
The lecture Energy and Transportation imparts profound knowledge of energy- and environment-related difficulties of the intersection of energy and transportation with focus on the motorized individual traffic. The students gain the ability to approach energy- and environment-related problems with special consideration of the demand side, and to evaluate possible solutions.

The main objectives of this lecture are:

(i) The students gain profound knowledge of energy- and environment-related difficulties of the intersection of energy and transportation, and learn strategies to cope with these difficulties.

(ii) The students are able to approach energy- and environment-related problems with special consideration of the demand side, and to evaluate possible solutions.


(iv) Technical potentials for the reduction of greenhouse gas (GHG) emissions and the dependence on fossil fuels: Evaluation of (a) alternative fuels, and (b) alternative propulsion systems.

(v) The relevance of demand on efforts to reduce GHG emissions and the dependence on fossil fuels.

(vi) Strategies and measures for influencing the demand side.

### Multidisciplinary Courses

The listed courses are specially recommended. Beyond these, the students are free to choose individually from the entire course offer of ETH Zürich, ETH Lausanne and the Universities of Zürich and St. Gallen.

### Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
</tbody>
</table>

Abstract

The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Objective

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

Content

- Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).
- Topic 2: Power Point Presentations.
- Topic 3: Citation Rules and Citation Software.
- Topic 4: Guidelines for Research Integrity.

Literature

ETH "Citation Etiquette", see www.plagiate.ethz.ch.


Prerequisites / notice

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1671-00L</td>
<td>Internship in Industry</td>
<td>O</td>
<td>8</td>
<td>20A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract

The semester project is designed to train the students in solving specific problems from the field of Energy Science & Technology. This project uses the technical and social skills acquired during the master's program. The semester project is advised by a professor and must be approved in advance by the tutor.

Objective

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

### Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1650-00L</td>
<td>Internship in Industry</td>
<td>O</td>
<td>8</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

Abstract

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective

see above

### Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-ITET.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

### Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
</tbody>
</table>

Strongly recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).
Abstract
The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Objective
Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

Content
* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the-Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).
* Topic 2: Power Point Presentations.
* Topic 3: Citation Rules and Citation Software.
* Topic 4: Guidelines for Research Integrity.

Literature
ETH "Citation Etiquette", see www.plagiate.ethz.ch.

Prerequisites / notice
Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>227-1601-00L Master's Thesis</th>
<th>O 30 credits 40D Supervisors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only students who fulfill the following criteria are allowed to begin with their master thesis: a. successful completion of the bachelor programme; b. fulfilling of any additional requirements necessary to gain admission to the master programme.</td>
<td></td>
</tr>
<tr>
<td>Registration in mystudies required!</td>
<td></td>
</tr>
</tbody>
</table>

Abstract
The master program in Energy Science and Technology culminates in a six months research project which addresses a scientific research question on one’s chosen area of specialization. The masters thesis is supervised by a program-affiliated faculty member and the topic must be approved in advance by the tutor.

Objective
see above

Energy Science and Technology Master - Key for Type

<table>
<thead>
<tr>
<th>W</th>
<th>Eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
</tbody>
</table>

| Dr | Suitable for doctorate |
| O | Compulsory |
| W+ | Eligible for credits and recommended |

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
</tbody>
</table>

| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Earth Sciences Bachelor

1. Semester

First Year Examinations

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

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

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

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

Lecture notes
ca. 360 Seiten mit vielen Figuren und durchgerechneten Beispielen.

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

401-0251-00L Mathematics I O 6 credits 4V+2U A. Cannas da Silva

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

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

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

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

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

Prerequisites / notice
Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

Assistance:
Mondays 12-13, Tuesdays 17-19, Wednesdays 17-19, in Room HG E 41.

551-0001-00L General Biology I O 3 credits 3V U. Sauer, A. Widmer

Abstract
Basics of structure, formation and function of cells and macromolecules, principles of metabolism, as well as basic classical and molecular genetics and evolutionary biology. First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.

Objective
The understanding of some basic principles of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its functions, as well as metabolism, inheritance and evolution.
The structure and function of biomacromolecules; basics of metabolism; cell biology; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, meiosis and sexual life cycles; Mendelian and molecular genetics; animal reproduction and behavior; sensory and motor mechanisms; population biology and evolution; principles of phylogeny.

The Campbell Chapters 1-4 (10th edition) under the heading “The role of chemistry in biology” are expected. We will treat the following Campbell chapters:

5 Biochemistry Biological Macromolecules and Lipids
7 Cell biology Cell Structure and Function
8 Cell biology Cell Membranes
10 Cell biology Cellular Respiration: An Introduction to Metabolism
10 Cell biology Cellular Respiration
11 Cell biology Photosynthesis
12 Cell Biology Mitosis
13 The Genetic Basis of Life Sexual Life Cycles and Meiosis
14 The Genetic Basis of Life Mendelian Genetics
15 The Genetic Basis of Life Linkage and Chromosomes
20 The Genetic Basis of Life The Evolution of Genomes
21 Evolution How Evolution Works
22 Evolution Phylogenetic Reconstruction
23 Evolution Microevolution
24 Evolution Species and Speciation
25 Evolution Macroevolution

The lecture is the first in a series of two lectures given over two semesters for students with biology as a basic subject.


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

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

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

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

Literature
Generelle Ökologie:
Aquatische Ökologie:
Lampert & Sommer 1999. Limnökologie. Thieme, 2. Aufl., ca. Fr. 55.-;
Bohle 1995. Limnische Systeme. Springer, ca. Fr. 50.-
Naturschutzbiologie:

651-3001-00L Dynamic Earth I
Alternate for 701-0025-00 Erd- und Produktionssysteme

Abstract
Provides a basic introduction into Earth Sciences, emphasizing different rock-types and the geological rock-cycle, as well as introduction into geophysics and plate tectonic theory.

Objective
Understanding basic geological and geophysical processes

Content
Overview of the Earth as a system, with emphasis on plate tectonic theory and the geological rock-cycle. Provides a basic introduction to crystals and minerals and different rock-types. Lectures include processes in the Earth's interior, physics of the earth, planetology, introduction to magmatic, metamorphic and sedimentary rocks. Exercises are conducted in small groups to provide more in depth understanding of concepts and content of the lectures.

Lecture notes
werden abgegeben.

Literature

Prerequisites / notice
Exercises and short excursions in small groups (10-15 students) will be lead by student assistants. Specific topics in earth sciences will be discussed using examples and case studies. Hand samples of the major rock types will be described and interpreted. Short excursions in the region of Zurich will permit direct experience with earth science processes (e.g. earth surface processes) and recognition of earth science problems and solutions relevant for modern society (e.g. building materials, water resources). Working in small groups will allow for discussion and examination of actual earth science themes.

First Year Additional Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>L. E. Fässler, H.J. Böckenhauer, M. Dahinden, D. Komm</td>
</tr>
</tbody>
</table>
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: publishing over the internet, processing and visualizing time series, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to macro programming, universal methods for algorithm design.

The students learn to
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

1. Simulation and Modeling
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

This course is based on application-oriented learning.
The students spend most of their time working through electronic tutorials and discussing their results with teaching assistants.

Laboratory Course: Elementary Chemical Techniques

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0033-04L</td>
<td>Laboratory Course in Physics for Students in Earth Sciences</td>
<td>O</td>
<td>2 credits</td>
<td>4P</td>
<td>A. Biland, M. Männich</td>
</tr>
</tbody>
</table>

The central aim is to provide an individual experience of the physical phenomena and the basic principles of the experiment. By conducting simple physical experiments the student will learn how to properly use physical instruments and how to evaluate the results correctly.

This laboratory course aims to provide basic knowledge of
- the setup of a physics experiment,
- the use of measurement instruments,
- various measuring techniques,
- the analysis or measurement errors,
- and the interpretation of the measured quantities.

Fehlerrechnung, 9 ausgewählte Versuche zu folgenden Themen:


The synthesis of simple inorganic complexes or organic molecules is practised.

Further, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

The students spend most of their time working through electronic tutorials and discussing their results with teaching assistants.

Laboratory Course: Crystals and Minerals

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3301-00L</td>
<td>Crystals and Minerals</td>
<td>W+</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>P. Brack, E. Reusser</td>
</tr>
</tbody>
</table>

To understand, qualitatively and semi-quantitatively, crystal and mineral formation, the interdependence between crystals structure, chemical composition and physical properties. This dependence is especially the case for the structural dependence of optical anisotropy and the elastic properties of the minerals as well as for the growth of crystals and their defect structures.

Qualitatives und teilweise quantitatives Verständnis für den Aufbau von Kristallen und Mineralien, für die Zusammenhänge zwischen chemischer Zusammensetzung, Kristallstruktur und physikalischen Eigenschaften, für das Wachstum von Kristallen sowie wichtiger identifikationsrelevanter makroskopischer Eigenschaften; selbständige Identifikation der rund 70 wichtigsten Mineralarten.

Symmetrien und Ordnung, Punkgruppen, Translationsgruppen, Raumgruppen.
- einfache Strukturtypen, dichte Kugelpackungen, Strukturbestimmende Faktoren
- Chemisch Bindungen, Beziehungen zwischen Struktur und Eigenschaften eine Kristalls.
- Grundlagen von Thermodynamik und Computersimulationen in der Kristallographie.
- Einführung in die Mineralogie und Mineralsystematik.
- Praktikum in Mineralbestimmen aufgrund makroskopischer Eigenschaften.

Details will be provided on the first day of the semester.

A thorough study of all script materials is requested before the course starts.

The script will be published on the web.

The central aim is to provide a broad understanding of the crystal and mineral formation, the interdependence between crystals structure, chemical composition and physical properties. This dependence is especially the case for the structural dependence of optical anisotropy and the elastic properties of the minerals as well as for the growth of crystals and their defect structures.

The general courses in Earth Sciences are offered in the 3rd and 4th semester. Out of 40 offered credits, 35 credits have to be acquired.
**Literature**

   Andrew Putnis.
   Hans-Rudolf Wenk, Andrei Bulakh

**651-3321-00L Interpretation of Geological Maps I**

**Abstract**
Introduction to reading and construction of simple geologic maps.
Construction of geological cross-sections.
Introduction to Lambert projection and Schmidt net (i.e., stereoplots).

**Objective**
This course is mainly a hands-on-training, where students solve exercises under supervision.

**Content**
- Learn how to read and interpret geological maps.
- Learn the handling of the Schmidt net, so that students can later plot their own field data.
- strike lines, symbols
- true and apparent thickness of geological units
- true and apparent dip
- V-rule
- unformities
- faults
- introduction to the Lambert projection
- folds
- magmatic structures

**Lecture notes**
Exercises and instructions are handed out and are available online in Moodle.

**Literature**
Semester literature can be found in the ERDW-library.

**Prerequisites / notice**
This course is not a prerequisite, but nevertheless extremely helpful for the Terrainkurs II.

**651-3323-00L Earth and Climate History**

**Abstract**
The goal of the course is to give the students a perception of the major aspects of planetary history and to add to their curiosity about methods which can be applied in the investigations of more specific problems and to planetary features.

**Objective**

**Content**
- Frühe Geschichte der Erde, der Litho-, Atmo- und Biosphäre; Phanerozoische Platten und Terranes; Entwicklung des Lebens im Phanerozön, Mesozoische Anoxia, Kreide-Tertiär-Grenze, Tertiäre Abkühlung, Messian-Salinitätskrise, Homininenentwicklung, Quartäre Klimaschwankungen.

**Lecture notes**
Unterlagen werden abgegeben.

**Literature**

### Examination Blocks

#### Examination Block 1

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

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

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

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

**Lecture notes**
Skript wird verteilt.

**Literature**
- Friedhelm Kuypers
  - Physik für Ingenieure und Naturwissenschaftler
  - Band 2 Elektrizität, Optik, Wellen
  - Verlag Wiley-VCH, 2003, Fr. 77.-

- Douglas C. Giancoli
  - Physik
  - 3. erweiterte Auflage
  - Pearson Studium

- Hans J. Paus
  - Physik in Experimenten und Beispielen
  - Carl Hanser Verlag, München, 2002, 1068 S.

- Paul A. Tipler
  - Physik
  - Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-

- David Halliday, Robert Resnick, Jearl Walker
  - Physik
  - Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03)

- dazu gratis Online Ressourcen (z.B. Simulationen): www.halliday.de

**651-3341-00L Lithosphere**

**Prerequisite:** successful completion of Dynamic Earth I and II is mandatory.
Abstract
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth. Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Objective
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth. Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Content

Lecture notes
Detailed scriptum in digital form and additional learning modules (www.lead.ethz.ch) available on intranet.

Literature
see list in scriptum.

Prerequisites / notice
PPT-files of each lecture may be played back for rehearsal on www.lead.ethz.ch.

701-0023-00L Atmosphere O 3 credits 2V H. Wernli, T. Peter

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes
Written information will be supplied.

Literature

Exam Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>701-0071-00L Mathematics III: Systems Analysis</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td></td>
<td>N. Gruber, P. Landschützer</td>
</tr>
</tbody>
</table>

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

Objective
Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.

Content
Content of lectures:
http://www.up.ethz.ch/education/system_analysis/index_DE

Homework:
http://www.up.ethz.ch/education/system_analysis/sA2/index_DE

Lecture notes
Overhead slides:
http://www.up.ethz.ch/education/system_analysis/index_DE

Literature


701-0401-00L Hydrosphere O 3 credits 2V P. Bayer, R. Kipfer

Abstract
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Objective
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Content
Topics of the course.
- Physical properties of water (i.e. density and equation of state)
- Global water resources
- Exchange at boundaries
- Energy (thermal & kinetic), gas exchange
- Mixing and transport processes in open waters
- Vertical stratification, large scale transport
- Turbulence and mixing
- Mixing and exchange processes in rivers
- Groundwater and its dynamics
- Ground water as part of the terrestrial water cycle
- Ground water hydraulics, Darcy's law
- Aquifers and their properties
- Hydrochemistry and tracer
- Ground water use
- Case studies
- 1. Water as resource, 2. Water and climate

Lecture notes
In addition to the suggested literature handouts are distributed.

Literature
Suggested literature.

Prerequisites / notice
The case studies and the analysis of the questions and problems are integral part of the course.

5. Semester Majors

Major in Geology

Advisor of the major in Geology is Prof. Stefano Bernasconi

Major in Geology: Core Courses

From the offered core courses in autumn and spring semester, 27 credits have to be acquired.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Term</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td>The course focuses on the most important systems of radioactive and stable isotopes used in geochemistry and geology. Applications of isotope geochemistry for solving fundamental geological problems are discussed on the basis of case studies.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td>Development of a basic knowledge and understanding of the applications of the most important systems of stable and radiogenic isotopes.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td>The following methods will be discussed in detail: the radioactive-radiogenic systems Rb-Sr, Sm-Nd, U-Th-Pb and K-Ar, as well as the stable isotope systems of oxygen, carbon, nitrogen, sulfur and hydrogen. We will discuss how these methods are used in the following research fields: geochemistry of the earth, age dating, paleotemperature reconstructions, evolution of the crust and mantle reservoirs, sediment diagenesis, fluid rock interactions, hydrothermal activity, paleoceanography, biogeochemical cycles.</td>
</tr>
</tbody>
</table>

Lecture notes available.

|             |                                                                 |         |       | - Dickin A. P., Radiogenic Isotope Geochemistry, (2005), Cambridge University Press |

Prerequisites: Geography I: (Bachelor course)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Term</th>
<th>Instructor(s)</th>
</tr>
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<tbody>
<tr>
<td>651-3501-00L</td>
<td>Metamorphism</td>
<td>3</td>
<td>W+</td>
<td>C. A. Heinrich, R. Kündig, W. Leu, F. Schenker</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td>Understanding of the principles governing (chemical) reactions in metamorphic processes and resulting (physical) properties of metamorphic rocks s.l.. Recognition of metamorphic minerals and rocks (e.g. Gesteinsbestimmung)</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td>- Vorstellung der Dozierenden mit Fallstudie aus der persönlichen Berufspraxis (CH, RK, WL, FS)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Resourcen der Welt und Bedeutung für die Schweiz (RK)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Metallische Erzlagertäten - Einführung (CH)</td>
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<td>- Metallische Erzlagertäten - Magmatische Prozesse Test 1 (CH)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>- Ozeanische Hydrothermalsysteme, Oberflächenenergie und Atmosphärentwicklung (CH)</td>
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<td></td>
<td>- Metallische Erzlagertäten - Magmatisch-hydrothermale Systeme Test 2 (CH)</td>
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<td></td>
<td></td>
<td>- Energierohstoffe - Einführung : Bildungsprozesse Petroleum und Erdgas (WL)</td>
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<td></td>
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<td></td>
<td>- Energierohstoffe - Kohle und CO2-Entsorgung Test 3 (WL/RK)</td>
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<td></td>
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<td></td>
<td>- Nichtmetallische Rohstoffe - Baustoffe (RK)</td>
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<td></td>
<td>- Nichtmetallische Rohstoffe - Erden (RK/FS)</td>
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<td></td>
<td>- Nichtmetallische Rohstoffe - Industriemineralien Test 4 (FS)</td>
</tr>
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<td></td>
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<td></td>
<td></td>
<td>- Industriemineralien und nachhaltige Nutzung von Rohstoffen der Erde (FS)</td>
</tr>
</tbody>
</table>

Lecture notes kursnotizen werden in den Stunden verteilt.

|             |                                                                 |         |       | - Dickin A. P., Radiogenic Isotope Geochemistry, (2005), Cambridge University Press |

Prerequisites: Geologie und mineralogische Grundkenntnisse aus Dynamische Erde I und II einschliesslich Uebungen in Gesteinsbestimmung; Buch von Grotzinger, Press & Siever. Anwesenheit in den Stunden ist essentiell -- Uebungen und 4 Kurzprüfungen zur Leistungskontrolle.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Term</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>651-3501-00L</td>
<td>Mineral Resources</td>
<td>3</td>
<td>W+</td>
<td>J. P. Burg, E. Kissling</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td>Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alp-Himalaya orogenetic system.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td>Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Assessment of mechanisms responsible for plate movements (the Earth as a heat transfer machine, dynamics of earth mantle, plate driving forces) and subsequent large-scale structures (oceanic basins and cycle of the oceanic lithosphere, convergence and mountain systems and continental growth, etc) through theoretical and experimental information. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alp-Himalaya orogenetic system.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td>Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, longifity and growth of continents, supercontinents. Rheology of layered lithosphere and upper mantle. Odontion systems Collisions systems Extensional systems Basin evolution Passive and active continental margin evolution</td>
</tr>
</tbody>
</table>

Lecture notes Detailed scriptum in digital form and additional learning modules (www.lead.ethz.ch) available on the intranet.
651-3523-00L Hydrogeology and Quaternary Geology  
**Abstract**  
This course provides the basics of quaternary geology and an overview of the aspects of the hydrogeology of quaternary sediments and karst within Switzerland. 

**Objective**  
- Become familiar with the processes that formed the landscapes during the last 2 Mio. years.  
- Understand the types of landscape and the forming quaternary sediments.  
- Get insight into the role of the quaternary aquifers and apply fundamental hydrogeological techniques.  
- Learn about the risk exposure of aquifers and ways to protect them.  
- Familiarize with the concepts for characterization of fractured and karst aquifers.  

**Content**  
- Erforschungsgeschichte und Gliederung des Quartärs, Klimaentwicklung.  
- Prozesse während Kaltzeiten (Eisvorstösse, glaziale Erosion) und während Warmzeiten (Sedimentation, fluviale Erosion) (mit Übungen).  
- Quartäre Geomorphologie, quartäre Ablagerungen (mit Übungen).  
- Entwicklungsgeschichte der Täler in den Alpen und im Alpenvorland (mit Übungen).  
- Altersbestimmungen, Quartärstratigraphische Methoden, Stratigraphie der Tälerräume.  
- Wiederholung Hydrogeologischer Grundlagen.  
- Grundwasservorkommen der Schweiz (mit Übungen).  
- Hydrogeologie quartärer Ablagerungen (namentlich fluvio-glaziale Schotter).  
- Nutzung und Bewirtschaftung der Grundwasservorkommen in quartären Ablagerungen (mit Übungen).  
- Grundwassernutzung im Hauptsiedlungsraum der Schweiz.  
- Gefährdung und Schutz der Grundwasservorkommen in quartären Lockergesteinen (mit Übungen).  
- Einführung in die Hydrogeologie von Kluft- und Karstgrundwasserleitern (mit Übung).  

**Lecture notes**  
Während der Vorlesung werden die wichtigsten Daten und Fakten auf Blättern abgegeben und im Internet zum Download bereitgestellt. 

**Literature**  
Zahlreiche Publikationen des BAFU zur Hydrologie und Hydrogeologie der Schweiz.  

**Prerequisites / notice**  
Voraussetzung erfolgreicher Abschluss von 701-0401-00 Hydrospäre
Overview and understanding of the most important geophysical methods. Proposed solutions to assess and observe problems relevant to exploration and environmental geochemistry in soil, ice and lithosphere at different scales. Getting familiar with measuring- and interpretation procedures. Pointing out the possibilities and limitations of geophysical methods.


Additional material will be provided by the lecturers.


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>651-3543-00L</td>
<td>Seismology</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>D. Giardini, D. Fäh</td>
</tr>
<tr>
<td>Objective</td>
<td>General knowlede of seismology.</td>
<td></td>
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<tr>
<td>Content</td>
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<tr>
<td>Literature</td>
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</tbody>
</table>

651-3597-00L  | Seminar I for Bachelorstudents                  | W+   | 2    | 2S    | W. Schatz, J. D. Rickli   |
| Abstract     | In this seminar, students learn to search effectively for scientific knowledge and how to present scientific results orally and in written form to different audiences. |
| Objective    | Students are able to held scientific presentations. |
| Content      | Students can plan and present a scientific poster. |
| Literature   | Students can search scientific publications in an effective and efficient manner. |

651-3501-00L  | Isotope Geochemistry and Isotope Geology        | W    | 3    | 2G    | S. Bernasconi, D. Vance   |
| Abstract     | The course focuses on the most important systems of radioactive and stable isotopes used in geochemistry and geology. Applications of isotope geochemistry for solving fundamental geological problems are discussed on the basis of case studies. |
| Objective    | Development of a basic knowledge and understanding of the applications of the most important systems of stable and radiogenic isotopes. |
| Content      | The following methods will be discussed in detail: the radioactive-radiogenic systems Rb-Sr, Sm-Nd, U-Th-Pb and K-Ar, as well as the stable isotope systems of oxygen, carbon, nitrogen, sulfur and hydrogen. |
| Literature   | We will discuss how these methods are used in the following research fields: geochemistry of the earth, age dating, palaeotemperature reconstructions, evolution of the crust and mantle reservoirs, sediment diagenesis, fluid rock interactions, hydrothermal activity, paleoceanography, biogeochemical cycles. |
| Prerequisites / notice | Additional material will be provided by the lecturers. |

651-3503-00L  | Metamorphism                                    | W    | 3    | 3G    | M. W. Schmidt              |
| Abstract     | Understanding of the principles governing (chemical) reactions in metamorphic processes and resulting (physical) properties of metamorphic rocks s.l., Recognition of metamorphic minerals and rocks (e.g. Gesteinsbestimmung) |

651-3523-00L  | Hydrogeology and Quaternary Geology             | W    | 3    | 2G    | M. Kleiapova, P. Haldimann |
| Abstract     | This course provides the basics of quaternary geology and an overview of the aspects of the hydrogeology of quaternary sediments and karst within Switzerland. |
| Objective    | - Become familiar with the processes that formed the landscapes during the last 2 Mio. years. |
|              | - Understand the types of landscape and the forming quaternary sediments. |
|              | - Get insight into the role of the quaternary aquifers and apply fundamental hydrogeological techniques. |
|              | - Learn about the risk exposure of aquifers and ways to protect |
|              | - Familiarize with the concepts for characterization of fractured and karst aquifers |

Additional material will be provided by the lecturers.

- Dickin A. P., Radiogenic Isotope Geology, (2005), Cambridge University Press

- William White (2011) Geochemistry
  http://www.geo.cornell.edu/geoology/classes/geo455/Chapters.HTML

Prerequisites:
- Geochemie I: (Bachelor course)
### 651-3541-00L

#### Content

Primary core courses of the BSc Earth Sciences majors should be chosen.

#### Literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>W</th>
<th>R</th>
<th>ECTS</th>
<th>Hours</th>
<th>Type</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3541-00L</td>
<td>Exploration and Environmental Geophysics</td>
<td>W+</td>
<td>4 credits</td>
<td>3V</td>
<td>F. Brogini, J. Doetsch</td>
<td></td>
<td></td>
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</tbody>
</table>

### 651-3527-00L

#### Content

This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

#### Literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3527-00L</td>
<td>Earth Science Mapping Exercises II</td>
</tr>
</tbody>
</table>

### 651-3525-00L

#### Content

This introductory course starts from a descriptions of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslide hazards are presented.

#### Literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3525-00L</td>
<td>Introduction to Engineering Geology</td>
</tr>
</tbody>
</table>

### Prerequisites / notice

Voraussetzung erfolgreicher Abschluss von 701-0401-00 Hydrosphäre

### Prerequisites / notice

Während der Vorlesung werden die wichtigsten Daten und Fakten auf Blättern abgegeben und im Internet zum Download bereitgestellt.

### Prerequisites

All 651-3500L - 3599L courses should be chosen.

### Credits

24 credits

### Hours

64 hours (not including self-study time)
Abstract Overview and understanding of the most important geophysical methods: Potential field methods (Gravimetrics and Magnetics), Electrical and electromagnetic methods, Refraction and reflection seismics, Georadar. Discussion of survey design, sources and receivers and data processing.

Objective Overview and understanding of the most important geophysical methods. Proposed solutions to assess and observe problems relevant to exploration and environmental geophysics in soil, ice and lithosphere at different scales. Getting familiar with measuring- and interpretation procedures. Pointing out the possibilities and limitations of geophysical methods.


Lecture notes Available through eDoz/ILIAS.

Literature Additional material will be provided by the lecturers.

651-3543-00L Seismology W+ 3 credits 2G D. Giardini, D. Fäh

Objective General knowlede of seismology.

Content Earth Science Mapping Exercises II

Reading and interpretation of geological and climatological maps.

W+ 2 credits 2P J.P. Burg

651-3525-00L Introduction to Engineering Geology W+ 3 credits 3G S. Löw

Objective Understanding the basic geotechnical and geomechanical properties and processes of rocks and soils. Understanding the interaction of rock and soils masses with technical systems. Understanding the fundamentals of geological hazards.


Lecture notes Exercises and instructions are handed out.

Literature Written course documentation available under "Kursunterlagen".


651-3523-00L Hydrogeology and Quaternary Geology W+ 3 credits 2G M. Kleipkev, P. Haldimann

Objective This course provides the basics of quaternary geology and an overview of the aspects of the hydrogeology of quaternary sediments and karst within Switzerland.

Content - Become familiar with the processes that formed the landscapes during the last 2 Mio. years.
- Understand the types of landscape and the forming quaternary sediments.
- Get insight into the role of the quaternary aquifers and apply fundamental hydrogeological techniques.
- Learn about the risk exposure of aquifers and ways to protect.
- Familiarize with the concepts for characterization of fractured and karst aquifers

Erforschungsgeschichte und Gliederung des Quartärs, Klimagebietentwicklung.


Lecture notes Während der Vorlesung werden die wichtigsten Daten und Fakten auf Blättern abgegeben und im Internet zum Download bereitgestellt.
Isotope Geochemistry and Isotope Geology

- Vorstellung der Dozierenden mit Fallstudie aus der persönlichen Berufspraxis (CH, RK, WL, FS)
- W+ W+
- J.P. Burg
- 3 credits
- C. A. Heinrich
- W+
- W+
- W+
- C. A. Heinrich, R. Kündig, W. Leu, F. Schenker
- W+
- C. A. Heinrich
- W+
- M. W. Schmidt
- W+
- S. Bernasconi, D. Vance
- W+
- S. Bernasconi, D. Vance
Content
The following methods will be discussed in detail: the radioactive-radiogenic systems Rb-Sr, Sm-Nd, U-Th-Pb and K-Ar, as well as the stable isotope systems of oxygen, carbon, nitrogen, sulfur and hydrogen.

We will discuss how these methods are used in the following research fields: geochemistry of the earth, age dating, paleotemperature reconstructions, evolution of the crust and mantle reservoirs, sediment diagenesis, fluid rock interactions, hydrothermal activity, paleoceanography, biogeochemical cycles.

Lecture notes
Available

Literature
- Dickin A. P., Radiogenic Isotope Geology, (2005), Cambridge University Press

Prerequisites / notice
Rb-Sr, Sm-Nd, U-Th-Pb and K-Ar, as well as the stable isotope systems of oxygen, carbon, nitrogen, sulfur and hydrogen.

William White (2011) Geochemistry
http://www.geo.cornell.edu/geology/classes/geo455/Chapters.HTML

Prerequisites:

Geophysical Seminars
In this seminar, students learn to search effectively for scientific knowledge and how to present scientific results orally and in written form to different audiences.

Number Title Type ECTS Hours Lecturers
651-3597-00L Seminar I for Bachelorstudents W+ 2 credits 2S M. Funk, M. Huss, K. Steffen
Abstract
In this seminar, students learn to search effectively for scientific knowledge and how to present scientific results orally and in written form to different audiences.

Objective
Students are able to held scientific presentations.
Students can plan and present a scientific poster.
Students can search scientific publications in an effective and efficient manner.

Content
Auftreten vor Publikum
(Gestik, Haltung, Sprechend und Sprache, Hemmungen abbauen)
Medieneinsatz
(Powerpoint Standard für wissenschaftliche Präsentationen, Stärken und Gefahren von Präsentationen mit Powerpoint; Einsatz von Text, Graphiken, Ton, Video, Animationen etc.)
Beantwortung von Fragen: das Nach-dem-Vortrag, Umgang mit Fragen, Verhalten in kritischen Situationen
Tipps zum Zeitmanagement
Kriterien für Bewertung von Vorträgen anwenden können und konstruktives Feedback geben können
(Was ist gut? Warum? Was ist nicht so gut? Warum nicht und wie wäre es besser?)
Strukturieren, Reduzieren, Fokussieren, Präzisieren. Gliederung und Aufbau eines Posters
Technische Anforderungen (Software, Drucken ...) Posterpräsentation
Effizientes Suchen nach wissenschaftlichen Publikationen (Bibliotheken, Datenbanken, search tools...)
Analyse von wissenschaftlichen Artikeln (Aufbau, Struktur, Beurteilung der Qualität...)

651-3561-00L Cryosphere W 3 credits 2V M. Funk, M. Huss, K. Steffen
Abstract
This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

Objective
Students are able
- to qualitatively describe the main components of the cryosphere and their role in the climate system
- to formally describe the relevant physical processes which determine the state of cryosphere components

Content
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system.
Each part is use to emphasized on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.

Lecture notes
handouts will be distributed during the teaching semester

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Lecture notes
handouts will be distributed during the teaching semester

Abstract
The lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.

Objective
The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds.

The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.

Content
- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical O3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: chemical properties, primary and secondary aerosol sources
- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols
- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

Lecture notes
Vorlesungsunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.

Prerequisites / notice
Attendance of the lecture "Atmosphäre" LV 701-0023-00L or equivalent is a pre-requisite.

701-0475-00L
Atmospheric Physics

Abstract
This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.

Objective
Students are able
- to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

Content
Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes; storms; importance of aerosols and clouds for climate and weather modification. clouds and precipitation

Lecture notes
Powerpoint slides and script will be made available

Literature
Rogers and Yau, A Short Course in Cloud Physics, Pergamon Press, 1989;
Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Elsevier, 2006

Prerequisites / notice
50% of the time we use the concept of "flipped classroom" (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning.

We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is an additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but not voluntary.

701-0461-00L
Numerical Methods in Environmental Sciences

Abstract
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Objective
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Content
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Lecture notes
Lecture notes are provided (CHF 10.- per copy).

Literature
List of literature is provided.

Prerequisites / notice
Die Vorlesung verlangt Vorkenntnisse in Linearer Algebra, Analysis und Physik (z.B. komplexe Zahlen, Beschreibung von eebenen Wellen, einfache gewöhnliche Differentialgleichungen)

701-0473-00L
Weather Systems

Abstract
This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

Objective
The students are able to
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how and when the influence of the atmospheric flow on different scales

Content
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; northatlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes
Lecture notes and slides

Literature
Atmospheric Science, An Introductory Survey
John M. Wallace and Peter V. Hobbs, Academic Press

Major in Climate and Water: Electives
In addition to the mandatory seminar for Bachelor Students: Atmosphere and Climate (course nr. 701-0459-00 in autumn semester) another 22 credits must be acquired from the offered elective courses during the 5th and 6th semester. The choice of other courses has to be granted by the advisor (Dr. Erich Fischer).

Number
Title
Type
ECTS
Hours
Lecturers

701-0459-00L
Seminar for Bachelor Students: Atmosphere and Climate
O
2 credits
2S
R. Knutti, E. M. Fischer, O. Stebler

Abstract
In this seminar all students in the realm of atmospheric and climate science convene to train presentation techniques (talks, posters) by means of classic and modern scientific articles.
M. Dettling

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical tools will be covered and software application will be practiced on R.

W. This course can only be offered to a limited number of students, however, in any case for everybody having to attend it compulsory. We beg you to sign in to this course early.

Prerequisites / notice

This course can only be offered to a limited number of students, however, in any case for everybody having to attend it compulsory. We beg you to sign in to this course early.

401-0649-00L Applied Statistical Regression

Objective

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical tools will be covered and software application will be practiced on R.

Content

Part 1 Emission, Immission, Transmission
- Fluxes of pollutants and their environmental impact
- physical and chemical processes leading to emission of pollutants
- mass and energy of processes
- Emission measurement techniques and concepts
- Quantification of emissions from individual and aggregated sources
- extent and development of the emissions (Switzerland and global)
- propagation and transport of pollutants (transmission)
- meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- dispersion models (Gaussian model, box model, receptor model)
- measurement concepts for ambient air (immission level)
- extent and development of ambient air mixing ratios
- goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (process-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be shown that the majority of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration, electrostatic precipitators, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms.
- Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
- Discussion of the technical possibilities to solve the actual air pollution problems.

Lecture notes

- Brigitte Buchmann, Air pollution control, Part I
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises

Literature

- Lecture slides and exercises
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises

Prerequisites / notice

College lectures on basic physics, chemistry and mathematics

401-0625-00L Air Pollution Control

Objective

The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. The students know the different techniques of air pollution control and their scientific basements. They are able to incorporate goals concerning the air quality into their engineering work.

Content

1st week: course organisation and presentation of the institute
2nd and 3rd week: introduction to oral presentation technique
11th week: introduction to poster presentation technique
12th and 13th week: poster design
14th week: concluding poster presentation

Lecture notes

Documents are offered via the course's web page.

Literature

Documents are offered via the course's web page.

Prerequisites / notice

This course can only be offered to a limited number of students, however, in any case for everybody having to attend it compulsory. We beg you to sign in to this course early.

102-0635-01L Air Pollution Control

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear models.

Content

- The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.
- residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.
- The students know the different techniques of air pollution control and their scientific basements. They are able to incorporate goals concerning the air quality into their engineering work.

Lecture notes

- College lectures on basic physics, chemistry and mathematics

Literature

- College lectures on basic physics, chemistry and mathematics

Prerequisites / notice

College lectures on basic physics, chemistry and mathematics

401-0621-00L Using R for Data Analysis and Graphics (Part I)

Abstract

The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

Objective

The students will be able to use the software R for simple data analysis.
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.

Lecture notes
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

Prerequisites / notice
The course resources will be provided via the Moodle web learning platform
Please login (with your ETH (or other University) username+password) at
https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145
Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology W 3 credits 2G+2U D. Or

Abstract
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Content
Weeks 1 to 3: Physical Properties of Soils and Other Porous Media
Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics)
- The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics
- Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2: Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils
Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Lecture notes
Biological Processes in the Vadose Zone
- An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wrath, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature
Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

701-0479-00L Environmental Fluid Dynamics W 3 credits 2G H. Wernli, M. Croci-Maspoli

Abstract
This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.

Objective
Students are able
- to name the bases, concepts and methods of environmental fluid dynamics.
- to understand and discuss the components of the basic physical equations in fluid dynamics
- to apply basic mathematical equations to simple problems of environmental fluid dynamics

Content
Basic physical terminology and mathematical laws:
Continuum hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on rotating earth.
Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems.
Scale analysis: dimensionless variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.
Waves in environmental fluid systems.

Lecture notes
In english language

Literature
Will be presented in class.
See also: web-site.

102-0455-01L Groundwater I W 3 credits 2G M. Willmann

Abstract
The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective
a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.
b) Students are able to formulate simple practical flow and transport problems.
c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.
d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

Content
Introduction, aquifers, groundwater use, sustainability, porosity.
Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.
Flow properties, Darcy's law, filter.
Flow equations, stream function.
Exercises: Darcy's law.
Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.
Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.
Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.
Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.
Transport processes.
Exercises: Computer workshop using PMWIN.
Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.
Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.
Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.
Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes
Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index
Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature
W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970
G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

Field Trips, Laboratory and Block Courses
The Practical Training in Atmosphere and Climate takes place in Spring Semester.

Electives
Courses can be chosen from the complete offerings of the ETH Zurich and University of Zurich.
Fundamentals of Natural Hazards Management

Abstract
Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:
- Risk analysis - What can happen?
- Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
- Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
- Explain causes for conflicts between risk perception and risk analysis.
- Explain how various hazard mitigation approaches reduce risk.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Explain the best alternative from a set of thinkable measures based on an evaluation scheme.
- Explain the principles of risk-governance.

Objective
- Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
- Explain causes for conflicts between risk perception and risk analysis.
- Explain how various hazard mitigation approaches reduce risk.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Explain the best alternative from a set of thinkable measures based on an evaluation scheme.
- Explain the principles of risk-governance.

Content
Die Vorlesung besteht aus folgenden Blöcken:
1) Einführung ins Vorgehenskonzept (1W)
2) Risikoanalyse (6W + Exkursion) mit:
   - Systemabgrenzung
   - Gefahrenbeurteilung
   - Expositions- und Folgenanalyse
3) Risikobewertung (2W)
4) Risikomanagement (2W + Exkursion)
5) Abschlussbesprechung (1W)

Choice of courses from the complete offerings of ETH and UZH.

Social Sciences
Recommended GESS compulsory elective courses (Type B) for D-ERDW.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Bachelor Seminar
The Bachelor Seminar (651-3698-00L) takes place in spring semester.

Bachelor Thesis
The Bachelor Thesis and Bachelor-Seminar are offered once per year in the 6th semester, in the spring.

Complementary Courses
The Complementary Courses take place in Spring Semester.

Earth Sciences Bachelor - Key for Type

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

Key for Hours

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Definition</th>
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<tbody>
<tr>
<td>V</td>
<td>Lecture</td>
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<td>G</td>
<td>Lecture with exercise</td>
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<tr>
<td>U</td>
<td>Exercise</td>
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<td>S</td>
<td>Seminar</td>
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<td>K</td>
<td>Colloquium</td>
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<td>P</td>
<td>Practical/laboratory course</td>
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<td>A</td>
<td>Independent project</td>
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<tr>
<td>D</td>
<td>Diploma thesis</td>
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<tr>
<td>R</td>
<td>Revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Earth Sciences Master
► Major in Geology

Compulsory Module in Analytical Methods in Earth Sciences

Students need to register for 6 credits in part A, and 6 credits in part B.

Part A: Microscopy Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4045-00L</td>
<td>Microscopy of Metamorphic Rocks</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>P. Nievergelt</td>
</tr>
<tr>
<td></td>
<td>Advanced knowledge in optical mineralogy</td>
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<td></td>
<td>Application of methods to determine minerals in thin sections Identification and characterisation of metamorphic minerals</td>
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<td></td>
<td>Description of rocks. Derive correct petrographic rock name, based on modal abundance and microstructure/texture</td>
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<tr>
<td></td>
<td>Interpretation of rock fabric/microstructure, parageneses and mineral reactions</td>
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<td></td>
<td>Repetition of principal optical properties and of microscopic methods to identify minerals. Emphasis on interpretation of interference figures. Study typical metamorphic rocks in thin sections Description and interpretation of parageneses and texture/microstructures. Study the age relationship of crystallisation and deformation. Estimation of metamorphic grade.</td>
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<tr>
<td></td>
<td>Quantitative determination of rock components</td>
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<tr>
<td></td>
<td>Scientific documentation: Descriptions, drawings, photomicroscopy using different kinds of illumination and using plane- or circular-polarised light.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Handouts with additional information on theory and for exercises, in English.</td>
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<tr>
<td>Literature</td>
<td>To brush up knowledge in optical mineralogy read the relevant chapters in the book of W.D. Nesse (2004): Tröger, W.D.: Introduction to optical mineralogy. 3. Ed. (2004). Figures from this book will be used in lectures. Besides the theory, this book describes all optical properties of important minerals. Petrographers working on varying types of silicate rocks should have a look at this book.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Participants should have basic knowledge in crystallography, mineralogy and petrology, and have taken practical courses in microscopy of thin sections, as well as lectures in metamorphic petrology and structural geology!</td>
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<td>Other microscopy courses at department D-ERDW are on: magmatic rocks, following this course in second half of semester (P. Ulmer, IGP; Inst. for Geochemistry and Petrology)</td>
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<tr>
<td></td>
<td>Sedimentary rocks (Geol. Institute)</td>
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<td></td>
<td>Ore minerals (reflected light microscopy, Th. Driesner, IGP)</td>
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<tr>
<td></td>
<td>Microstructures, deformed rocks (Geol. Institute)</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4047-00L</td>
<td>Microscopy of Magmatic Rocks</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>P. Ulmer</td>
</tr>
<tr>
<td></td>
<td>This course provides basic knowledge in microscopy of igneous rocks. Apart from the identification of common igneous minerals in thin sections, mineral assemblages, textures and structures will be investigated and the results of microscopy will be combined with igneous phase equilibria to understand generation, differentiation and emplacement of igneous rocks.</td>
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<tr>
<td></td>
<td>The principal goal of this course is to acquire expertise in:</td>
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<td></td>
<td>(1) optical determination of minerals in igneous rocks using the polarizing microscope</td>
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<td>(2) Identification of igneous rocks basing on modal mineralogy, structure and texture;</td>
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<td></td>
<td>(3) Interpretation of textures and structures and associated igneous processes;</td>
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<td></td>
<td>(4) Application of igneous phase diagrams to natural rocks.</td>
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<td></td>
<td>This practical course bases on the course `Microscopy of metamorphic rocks' (P. Nievergelt), that is taught immediately before this course, where basic knowledge in optical mineralogy and the use of the polarizing microscope is acquired. In this course, the most important (common) igneous minerals and rocks are studied in thin sections under the polarizing microscope. Mineral assemblages, structures, textures and crystallization sequences are determined and utilized to understand the generation, differentiation and emplacement of igneous rocks. In addition, we will apply igneous phase equilibria that have been introduced in other lectures (such as magmatism and volcanism at ETH/Uni Zurich or an equivalent igneous petrology course) to natural rock samples in order to constrain qualitatively parental magma compositions and crystallization conditions. The range of investigated rocks encompasses mantle rocks, tholeiitic, calc-alkaline and alkaline plutonic and volcanic rocks that contain the most common igneous minerals.</td>
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<tr>
<td>Lecture notes</td>
<td>Basis of the optical determinations of (igneous) minerals using the polarizing microscope are the tables of Tröger (‘Optische Bestimmung der gesteinsbildenden Minerale', Optical determination of rock-forming minerals, 1982) that are available in sufficient volumes in the class room. Some loose sheets will be distributed during the lecture providing additional information and templates for thin section descriptions. Additionally, I recommend the lecture notes of H.-G. Stosch (University of Karlsruhe, in German) that can be provided in printed form upon request.</td>
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</tr>
<tr>
<td>Literature</td>
<td>There are several good textbooks on the subject of 'mineralogy in thin sections' that I can suggest upon request. This course does not include an introduction in optical mineralogy and the use of a polarizing microscope and, therefore, bases on the course 'Microscopy of metamorphic rocks' taught by P. Nievergelt immediately before this course where these basic principles are provided. Alternatively, e.g. for external students, an equivalent course is required to follow this practical course.</td>
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<td></td>
<td>Other microscopy courses taught at ETH Zurich at the D-ERDW are:</td>
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<tr>
<td></td>
<td>Microscopy of metamorphic rocks (P. Nievergelt, required for this course)</td>
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<tr>
<td></td>
<td>Microscopy of sedimentary rocks (W. Winkler &amp; Blaesi)</td>
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<td></td>
<td>Reflected light microscopy and ore deposits practical (T. Driesner)</td>
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<tr>
<td>Microstructures (Geol. Institute)</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4113-00L</td>
<td>Sedimentary Petrography and Microscopy</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>V. Picotti, M. G. Fellin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Microscopy of carbonate (1st half of semester) and silicilastic rocks (2nd half) rocks as well as siliceous, phosphatic and evaporitic sediments.</td>
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<tr>
<td>Objective</td>
<td>Description of grains and cement/matrix, texture, classification of the main sedimentary rocks. Discussion and interpretation of the environment of sedimentation. Diagenetic Processes.</td>
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<tr>
<td>Content</td>
<td>Microscopy of carbonate and silicilastic rocks, siliceous and phosphatic rocks, their origin and classification. Diagenesis.</td>
<td></td>
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<tr>
<td>Lecture notes</td>
<td>To be handed out in class</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The earlier attendance of other MSc microscopy courses (e.g. magmatic and metamorphic rocks) is not required if during the BSc a general course on microscopy of rocks was completed.</td>
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</table>

### Part B: Methods

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4055-00L</td>
<td>Analytical Methods in Petrology and Geology</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>E. Reusser, S. Bernasconi, M. Wälle, L. Zehnder</td>
</tr>
<tr>
<td>Abstract</td>
<td>Practical work in analytical chemistry for Earth science students.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of some analytical methods used in Earth sciences.</td>
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<tr>
<td>Content</td>
<td>Introduction to analytical chemistry and atom physics. X-ray diffraction (XRD), X-ray fluorescence analysis (XRF), Electron Probe Microanalysis (EPMA), Laser ablation inductively coupled plasma mass spectroscopy (LA-ICP-MS), Mass spectroscopy for light isotopes.</td>
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<tr>
<td>Lecture notes</td>
<td>Short handouts for each analytical method.</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Geographic Information Systems</th>
<th>W+</th>
<th>3</th>
<th>4G</th>
<th>A. Baltensweiler, M. Hägeli-Golay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Introduction to the architecture and data processing capabilities of geographic information systems (GIS). Practical application of spatial data modeling and geoprocessing functions to a selected project from the earth sciences.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of the basic architecture and spatial data handling capabilities of geographic information systems.</td>
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<tr>
<td>Content</td>
<td>Theoretical introduction to the architecture, modules, spatial data types and spatial data handling functions of geographic information systems (GIS). Application of data modeling principles and geoprocessing capabilities using ArcGIS: Data design and modeling, data acquisition, data integration, spatial analysis of vector and raster data, particular functions for digital terrain modeling and hydrology, map generation and 3D-visualization.</td>
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<tr>
<td>Lecture notes</td>
<td>Introduction to Geographic Information Systems, Tutorial: Introduction to ArcGIS Desktop</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>X-ray Powder Diffraction</th>
<th>W+</th>
<th>3</th>
<th>2G</th>
<th>L. M. Plötze</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.</td>
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<tr>
<td>Objective</td>
<td>Upon successful completion of this course students are able to:</td>
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<tr>
<td></td>
<td>- describe the principle of X-ray diffraction analysis</td>
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<td></td>
<td>- carry out a qualitative and quantitative mineralogical analysis independently,</td>
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<td>- critically assess the data,</td>
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<td></td>
<td>- communicate the results in a scientific report.</td>
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<tr>
<td>Content</td>
<td>Fundamental principles of X-ray diffraction</td>
<td></td>
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<tr>
<td></td>
<td>Setup and operation of X-ray diffractometers</td>
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<tr>
<td></td>
<td>Interpretation of powder diffraction data</td>
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<td></td>
<td>Qualitative and quantitative phase analysis of crystalline powders (e.g. with Rietveld analysis)</td>
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<tr>
<td>Lecture notes</td>
<td>Selected handouts will be made available in the lecture</td>
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</tbody>
</table>
This course gives a tool to describe and interpret microstructures of deformed rocks. It begins with the definition of fabric elements and classification of cleavages. The second part deals with the relation between fabric, microstructure and deformation mechanisms. Finally will be examined the microstructures of high strain zones and the tools to quantify fabric and microstructure.

A substantial part of the lecture will take place in the computer-lab, where numerical finite element codes will be applied. The used software is Matlab. Students may bring their own laptop with a pre-installed copy of Matlab.

Final project-based work tailored to the student's interest.

Introduction to the finite-element method for modeling rock deformation in 2D.

Mathematical equations describing rock rheology: elasticity + viscosity.

Learning and understanding the continuum mechanics equations necessary to describe rock deformation.

Rheological equations: elasticity + viscous materials

Continuum mechanics equations describing rock deformation

Numerical integration + isoparametric elements

Introduction to the finite-element method in 1D

Going to 2D finite elements

Finite-element methods for 2D elasticity

Stress calculation + visualization

Finite-element method for 2D viscous materials

Heterogeneous media

Final project-based work tailored to the student's interest.

A substantial part of the lecture will take place in the computer-lab, where numerical finite element codes will be applied. The used software is Matlab. Students may bring their own laptop with a pre-installed copy of Matlab.

The script is very diverse and ranges from PowerPoint-based pdf-files, to self-study tutorials. Also, the more theoretical and mathematical aspects will be explained on the black board without a proper script.

All lecture-presentations, as well as the numerical codes, will be made available to the students online.

There is no mandatory literature. The following literature is recommended:


A good knowledge of linear algebra is expected.

Finite-element method for 2D viscous materials

Introduction to the finite-element method (in 1D)

Rheological equations: elasticity + viscous materials

Introduction to the finite-element method in 1D

Numerical integration + isoparametric elements

Going to 2D finite elements

Finite-element methods for 2D elasticity

Stress calculation + visualization

Finite-element method for 2D viscous materials

Heterogeneous media

Final project-based work tailored to the student's interest.

A substantial part of the lecture will take place in the computer-lab, where numerical finite element codes will be applied. The used software is Matlab. Students may bring their own laptop with a pre-installed copy of Matlab.

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Finite-element method for 2D viscous materials

Introduction to the finite-element method (in 1D)

Rheological equations: elasticity + viscous materials

Introduction to the finite-element method in 1D

Numerical integration + isoparametric elements

Going to 2D finite elements

Finite-element methods for 2D elasticity

Stress calculation + visualization

Finite-element method for 2D viscous materials

Heterogeneous media

Final project-based work tailored to the student's interest.

A substantial part of the lecture will take place in the computer-lab, where numerical finite element codes will be applied. The used software is Matlab. Students may bring their own laptop with a pre-installed copy of Matlab.

The script is very diverse and ranges from PowerPoint-based pdf-files, to self-study tutorials. Also, the more theoretical and mathematical aspects will be explained on the black board without a proper script.

All lecture-presentations, as well as the numerical codes, will be made available to the students online.

There is no mandatory literature. The following literature is recommended:


A good knowledge of linear algebra is expected.
Content 1) Terminology: grain, grain shape, grain boundaries, cracks, cleavages.

2) Recall Foliation mechanisms and their microstructures:
a. passive rotation (examples of mica in marbles)
b. dissolution and precipitation (+Q and M domains in schists)
c. nucleation and growth (metamorphism, e.g. low grade schists)
d. crystal plastic deformation (e.g. calcite, quartz)
e. recrystallization (dynamic) (e.g. calcite)

3) Deformation mechanisms, their microstructures and CPO
a. Cataclastic deformation (cataclastic flow, trails of fluid inclusions, interaction with fluids and melt, pseudotachylytes, breccias)
b. Intracrystalline plasticity (monomineralic calcite, olivine, quartz.microstructures and CPO, progressive deformation in simple and pure shear)
c. Diffusive mass transfer in presence of fluids (pressure solution)
d. Solid state
e. Grain boundary sliding and superplastic flow (calcite)
g. Twinning (calcite, as thermometer; plagioclase)
h. Recovery and static recrystallization
i. Deformation of polyminerical rocks (e.g. quartzfeldspatic and schists)
j. synkinematic mineral reactions

4) Microstructures in Fault rocks
a. Fault gouge
b. Mylonites (evolution of microstructures and PO with progressive strain. Natural examples and the experimental results from torsion testing: calcite and olivine).
c. Sense of shear: Matrix, Porphyroclasts etc.

5) Advanced techniques for microstructural characterization
a. Electron microscopy (SEM, TEM, FIB, EDX, EBSD)
b. Texture goniometry

Lecture notes Practical microscopy session!

651-4111-00L Rock Physics W 3 credits 2G A. S. Zappone, K. Kunze, C. Madonna, S. Subramaniyan

Abstract The modern discipline of Rock Physics serves as a bridge between traditional Rock Mechanics and traditional Rock Physical Property measurement. Through understanding the physics of the process, we strive to better understand other related fields such as structural geology and geophysics.

Objective The objective of this course is to introduce Rock Physics as a laboratory and interpretive tool.

Content The course will consists of regular classes, with a small number of laboratory demonstrations made on an ad-hoc basis (depending on equipment and research objective schedules at the Rock Deformation Laboratory). The course will cover measurements of physical properties of rock such as density, porosity, permeability and elastic wave velocity, and will introduce the concept of seismic seismic anisotropy etc. Later we will cover rock deformation in the brittle field, earthquake physics and triggering. Finally we will discuss scale effects as we move from small scale laboratory environment to the scale of the geophysical investigation.

Prerequisites / notice Undergraduate courses in the following subjects are highly recommended in order to get the most out of this specialist course:
- Basic structural Geology
- Geophysics

651-3521-00L Tectonics W 3 credits 2V J.P. Burg, E. Kissling

Abstract Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Objective Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Assessment of mechanisms responsible for plate movements (the Earth as a heat transfer machine, dynamics of earth mantle, plate driving forces) and subsequent large-scale structures (oceanic basins and cycle of the oceanic lithosphere, convergence and mountain systems and continental growth, etc) through theoretical and experimental information. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Content Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, longlifety and growth of continents, supercontinents. Rheology of layered lithosphere and upper mantle. Obduction systems Collisions systems Extensional systems Basin evolution Passive and active continental margin evolution

Lecture notes Detailed scriptum in digital form and additional learning moduls (www.lead.ethz.ch) available on the intranet.


Sedimentology

Table: Sedimentology: Physical Processes and Sedimentary Systems

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<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4041-00L</td>
<td>Sedimentology I: Physical Processes and Sedimentary Systems</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>V. Picotti</td>
</tr>
</tbody>
</table>

Abstract Sediments preserved a record of past landscapes. This courses focuses on understanding the processes that modify sedimentary landscapes with time and how we can read this changes in the sedimentary record.
Objective

The students learn basic concepts of modern sedimentology and stratigraphy in the context of sequence stratigraphy and sea level change. They discuss the advantages and pitfalls of the method and look beyond. In particular we pay attention to introducing the importance of considering entire sediment routing systems and understanding their functionning.

Content

Details on the program will be handed out during the first lecture.

Literature

We will attribute the papers for presentation on the 26th, so please be here on that day!

Prerequisites / notice

The grading of students is based on in-class exercises and end-semester examination.

651-4043-00L Sedimentology II: Biological and Chemical Processes

O 3 credits 2G  V. Picotti, A. Gilli

651-4041-00L Sedimentology I

in Lacustrine and Marine Systems

For this course the successful completion of the MSc-course “Sedimentology I” (651-4041-00L) is a condition.

Abstract

The course will focus on biological amd chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography.

Objective

- You will understand chemistry and biology of the marine carbonate system
- You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle
- You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)
- You will have an overview of marine sedimentation through time
- Communicate the results in a scientific report.
- Critically assess the data,
- Carry out a qualitative and quantitative mineralogical analysis independently
- Describe the principle of X-ray diffraction analysis
- Qualitative and quantitative phase analysis of crystalline powders (e.g. with Rietveld analysis)
- Economic aspects of limestone

Content

- Carbonates: chemistry, mineralogy, biology
- Carbonate sedimentation from the shell to the deep sea
- Carbonate facies
- Cool-water and warm-water carbonates
- Organic-carbon and black shales
- C-cycle, carbonates, Corg : CO2 sources and sink
- Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
- Marine sediments through geological time
- Carbonates and evaporites
- Lacustrine carbonates
- Economic aspects of limestone

Lecture notes

No script. Scientific articles will be distributed during the course.

Literature

We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems".

Prerequisites / notice

The grading of students is based on in-class exercises and end-semester examination.

651-4901-00L Quaternary Dating Methods

W 3 credits 2G  I. Hajdas, S. Ivy Ochs

Abstract

Reconstruction of time scales is critical for all Quaternary studies in both Geology and Archeology. Various methods are applied depending on the time range of interest and the archive studied. In this lecture we focus on the six methods that are most frequently used for dating Quaternary sediments and landforms.

Objective

Students will be made familiar with the details of the six dating methods through lectures on basic principles, analysis of case studies, solving of problem sets for age calculation and visits to dating laboratories.

At the end of the course students will:

1. Understand the fundamental principles of the most frequently used dating methods for Quaternary studies.
2. Be able to calculate an age based on data of the six methods studied.
3. Choose which dating method (or combination of methods) is suitable for a certain field problem.
4. Critically read and evaluate the application of dating methods in scientific publications.

Content

1. Introduction: Time scales for the Quaternary, isotopes and decay
2. Radiocarbon dating: principles and applications
3. Cosmogenic nuclides: 3He,10Be, 14C, 21Ne, 26Cl, 36Cl
4. U-series disequilibrium dating
5. Luminescence dating
6. K/Ar and Ar/Ar dating of lava flows and ash layers
7. Cs-137 and Pb-210 (soil, sediments, ice core)
8. Summary and comparison of results from several dating methods at specific sites

Prerequisites / notice

Visit to radiocarbon lab, cosmogenic nuclide lab, noble gas lab, accelerator (AMS) facility.

651-4063-00L X-ray Powder Diffraction

W 3 credits 2G  L. M. Plötz

Number of participants limited to 12.

Abstract

In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for quantitative and qualitative mineral composition analysis as well as crystallographic parameters.

Objective

Upon successful completion of this course students are able to:
- Describe the principle of X-ray diffraction analysis
- Carry out a qualitative and quantitative mineralogical analysis independently
- Critically assess the data,
- Communicate the results in a scientific report.

Content

Fundamental principles of X-ray diffraction
Setup and operation of X-ray diffractometers
Interpretation of powder diffraction data
Qualitative and quantitative phase analysis of crystalline powders (e.g. with Rietveld analysis)

Lecture notes

Selected handouts will be made available in the lecture

Literature


The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data.

Own sample will be analysed quantitatively and qualitatively. Knowledge in mineralogy of this system is essential.

The lecture course is limited to 12 participants.

### Palaeoclimatology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>G. Haug, A. Martinez-Garcia</td>
</tr>
</tbody>
</table>

**Abstract**
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimate research. The student will have an understanding of evolution of climate and its major forcing factors - orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary palaeoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

**Objective**
- You will understand chemistry and biology of the marine carbonate system
- You will be able to relate carbonate mineralogy with facies and environmental conditions
- You will be familiar with cool-water and warm-water carbonates
- You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle
- You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)
- You will be able to use geological archives as source of information on global change
- You will have an overview of marine sedimentation through time

**Content**
- Carbonates: chemistry, mineralogy, biology
- Carbonate sedimentation from the shelf to the deep sea
- Carbonate facies
- Cool-water and warm-water carbonates
- Organic-carbon and black shales
- C-cycle, carbonates, Corg : CO2 sources and sink
- Carbonates: their geochemical proxies for environmental change; stable isotopes, Mg/Ca, Sr
- Marine sediments through geological time
- Carbonates and evaporites
- Lacustrine carbonates
- Economic aspects of limestone

**Literature**
We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems".

The grading of students is based on in-class exercises and end-semester examination.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4058-00L</td>
<td>Basics of Palaeobotany (University of Zurich)</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
The course "Basics in Palaeobotany gives an overview on the evolution and palaeobiology of plants and their relevance for the reconstruction of past environments.

**Objective**
- You will understand how plants are preserved in the fossil record, to describe the morphology of plant mega fossils, and of spores and pollen. They can describe how plant fossils can be used for reconstructing palaeoenvironments. Students should be able to explain the interactions between evolution of plants, climate and physical environment and they will be able to integrate the dimension of geological time into their understanding of biological events.
Content
- Preservation of plants in the fossil record.
- First evidence for plants on Earth
- The conquest of the continents by plants
- Major adaptation and innovations leading to the present plant diversity
- The evolution and morphology of the major plant groups
- Plant associations through geological time and their palaeogeographic and stratigraphic relevance
- Mass extinctions and the fossil plant record
- Interaction between past vegetation and climate
- The relevance of plant microfossils for reconstruction of palaeoclimatic and palaeoeocology

Biogeochemistry

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4043-00L</td>
<td>Sedimentology II: Biological and Chemical Processes in Lacustrine and Marine Systems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>V. Picotti, A. Gilli</td>
</tr>
</tbody>
</table>

Abstract
The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes palaeoceanography will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography.

Objective
- You will understand chemistry and biology of the marine carbonate system
- You will be able to relate carbonate mineralogy with facies and environmental conditions
- You will be familiar with cool-water and warm-water carbonates
- You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle
- You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)
- You will be able to use geological archives as source of information on global change
- You will have an overview of marine sedimentation through time

Content
- carbonates, chemistry, mineralogy, biology
- carbonate sedimentation from the shelf to the deep sea
- carbonate facies
- cool-water and warm-water carbonates
- organic-carbon and black shales
- C-cycle, carbonates, Corg : CO2 sources and sink
- Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
- marine sediments thorough geological time
- carbonates and evaporites
- lacustrine carbonates
- economic aspects of limestone

Lecture notes
no script. scientific articles will be distributed during the course

Literature
We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems"

Prerequisites / notice
The grading of students is based on in-class exercises and end-semester examination.

651-4057-00L | Climate History and Palaeoclimatology | W    | 3 credits | 2G    | G. Haug, A. Martinez-Garcia |

Abstract
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimatic research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics- through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochanical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
- Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.
- Geological time, stratigraphy, geological archives, climate archives, palaeoclimate proxies
- Climate through geological time: "lessons from the past"
- Cretaceous greenhouse climate
- The Late Paleocene Thermal Maximum (PETM)
- Cenozoic Cooling
- Onset and Intensification of Southern Hemisphere Glaciation
- Onset and Intensification of Northern Hemisphere Glaciation
- Pliocene warmth
- Glacial and Interglacials
- Millennial-scale climate variability during glaciations
- The last deglaciation(s)
- The Younger Dryas
- Holocene climate - climate and societies

651-4058-00L | Basics of Palaeobotany (University of Zurich) | W    | 3 credits | 2G    | University lecturers |

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO280

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html
Abstract: The course "Basics in Palaeobotany" gives an overview on the evolution and palaeobiology of plants and their relevance for the reconstruction of past environments.

Objective: On successful completion of the module, the students should be able to explain how plants are preserved in the fossil record, to describe the morphology of plant mega fossils, and of spores and pollen. They can describe how plant fossils can be used for reconstructing palaeoenvironments. Students should be able to explain the interactions between evolution of plants, climate and physical environment and they will be able to integrate the dimension of geological time into their understanding of biological events.

Content:
- Preservation of plants in the fossil record.
- First evidence for plants on Earth
- The conquest of the continents by plants
- Major adaptation and innovations leading to the present plant diversity
- The evolution and morphology of the major plant groups
- Plant associations through geological time and their palaeogeographic and stratigraphic relevance
- Mass extinctions and the fossil plant record
- Interaction between past vegetation and climate
- The relevance of plant microfossils for reconstruction of palaeoclimatic and palaeoecology

Open Choice Modules: Quaternary Geology and Geomorphology

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-4901-00L</td>
<td>Quaternary Dating Methods</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>I. Hajdas, S. Ivy Ochs</td>
</tr>
</tbody>
</table>

Abstract: Reconstruction of time scales is critical for all Quaternary studies in both Geology and Archeology. Various methods are applied depending on the time range of interest and the archive studied. In this lecture we focus on the six methods that are most frequently used for dating Quaternary sediments and landforms.

Objective: Students will be made familiar with the details of the six dating methods through lectures on basic principles, analysis of case studies, solving of problem sets for age calculation and visits to dating laboratories.

Content:
1. Introduction: Time scales for the Quaternary, Isotopes and decay
2. Radiocarbon dating: principles and applications
3. Cosmogenic nuclides: 3He,10Be, 14C, 21Ne, 26Cl, 36Cl
4. U-series disequilibrium dating
5. Luminescence dating
6. K/Ar and Ar/Ar dating of lava flows and ash layers
7. Cs-137 and Pb-210 (soil, sediments, ice core)
8. Summary and comparison of results from several dating methods at specific sites
9. The relevance of plant microfossils for reconstruction of palaeoclimatic and palaeoecological processes

Prerequisites / notice: Visit to radiocarbon lab, cosmogenic nuclide lab, noble gas lab, accelerator (AMS) facility.

Required attending the lecture, visiting laboratories, handing back solutions for problem sets (Exercises)

Quaternary Sediments and Landforms:

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-4077-00L</td>
<td>Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)</td>
<td>W</td>
<td>3 credits</td>
<td>1V</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Abstract: Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

Objective: Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Content: Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff. Processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep/rock glaciers, debris flows).

Required attending the lecture, visiting laboratories, solving of problem sets for age calculation and visits to dating laboratories.

Oceanic Processes: Geodynamics of the Lithosphere

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-4231-00L</td>
<td>Basin Analysis</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>K. Ueda, T. I. Eglinton</td>
</tr>
</tbody>
</table>

Abstract: The course discusses the formation and development of different basin types as part of lithosphere geodynamics. It introduces conceptual models and governing physics, with practical application to the study of basin evolution. Techniques for the analysis of subsidence and thermal history are demonstrated. Organic matter, petroleum play, and their biogeochemical investigation are examined.

Objective: Based on the introductory education and practical training during this course, each participant should be able to choose and apply approaches and techniques to own problems of basin analysis, and should be versed to expand their knowledge independently.

In particular, each participant should:
- Develop an intuitive understanding for origin, dynamics, and temporal evolution of basins in a geological / geodynamic context;
- Acquire the necessary theoretical foundation to describe basin evolution quantitatively;
- Be familiar with geological and geophysical methods that are applied to obtain information about rock properties, structural geometry, and thermal and subsidence history of basins;
- Understand the burial and maturation of organic matter in basins, the development of petroleum play, and be acquainted with geochemical methods to study the evolution of biogenic carbon.
The following topics are covered:

- Introduction; classification schemes and types of basins; heat conduction; geotherms;
- The lithosphere; isostasy; rifts and basins due to lithospheric stretching; uniform extension model; modifications to the uniform stretching model; dynamics of rifting.
- Elasticity of the lithosphere; flexural compensation; geometry and analytical description of loads and the resulting deflection; foreland basins; their anatomy;
- Reconstruction of basin evolution; borehole data; porosity loss and decompaction; backstripping; subsidence curves; thermal history and its reconstruction;
- Petroleum play concept; organic production; source rock prediction and depositional environment; petroleum generation, expulsion, migration, alteration; reservoir and traps;
- Carbon cycle; maturation of organic matter; geochemistry of biogenic carbon; biomarkers; analytical techniques
- Overview of other basin types: effects of mantle dynamics, strike-slip basins.

Each week of the course is split in lectures and corresponding practicals, in which the concepts are applied to simplified problems.

Grading of the semester performance is based on submitted practicals (50%) and a final exam (50%). The exam will take place in the time slot of the last practical (18.12.).

Lecture notes

Lecture notes are provided online during the course. They summarize the current subjects week by week, and provide the essential theoretical background.

Literature

Main reference:


Recommended, but not required (available in library).

Supplementary:


Prerequisites / notice

Familiarity with MATLAB is advantageous, but not required.

651-4243-00L Seismic Stratigraphy and Facies W 2 credits 3G G. Eberli

Abstract

Introduction into seismic interpretation for solving geological and environmental problems. A special focus is given to the seismic facies analysis and seismic sequence stratigraphy. In addition, the seismic attributes are explained, which are important for the analysis of paleo-geomorphology and structural deformation.

Objective

1. Acquire techniques for a comprehensive interpretation of seismic sections for solving geologic, tectonic, stratigraphic and environmental problems
2. Correlation of seismic facies to lithologic facies in different sedimentary systems
3. Recognition of structural elements and faults on seismic sections.
4. Learning the techniques of 3D seismic data interpretation
5. Reconstruction of sedimentary history using seismic stratigraphy and facies analysis and core information.

Content

The four day course consists of lectures that are accompanied by a variety of exercises.

Day 1:
Introduction seismic facies analysis with exercise
Seismic resolution
Factors controlling sedimentation
Exercise: Seismic section in Straits of Florida

Day 2:
Seismic attributes and seismic geomorphology
Siliciclastic deltas, shelves and turbidite systems, 2D-3D
Exercise: Seismic section Tarragon Basin
Seismic facies carbonates
Exercise: Seismic section platform margin Great Bahama Bank
Deepwater environments, including cold-water coral habitats

Day 3:
Seismic facies of mixed systems with exercises
Faults and structures on seismic sections
Exercise: Seismic section Gulf von Mexiko

Day 4:
Telling ages on seismic section
Seismic stratigraphy and sequence stratigraphy
Exercise: Sequence analysis Straits of Andros
Final discussion
Lecture notes An original script (110 pages) designed for the class will be distributed at the beginning of the course.

Literature

Books Seismic Facies:


Books Seismic Stratigraphy:


Harris, P.M., Saller, A.H., and Simo, J.A. (eds.), 1999, Advances in carbonate sequence stratigraphy; application to reservoirs, outcrops, and models. SEPM Special Publication v. 83.


Schlager, W., 1992, Sedimentology and sequence stratigraphy of reefs and carbonate platforms: AAPG Cont. Education course notes #34, pp71.


Prerequisites / notice
Basic knowledge in sedimentology and stratigraphy

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-4107-00L</td>
<td>Rock and Environmental Magnetism</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>A. M. Hirt</td>
</tr>
</tbody>
</table>

Abstract
The course will cover basic physical theory related to mineral and rock magnetism, measurement techniques, and applications in earth and soil sciences, climatology and biophysics

Objective
There are two objectives in this course: (1) to acquire an understanding of the physical theory behind the origin of magnetism in a mineral or rock; and (2) to learn how material magnetic properties can be used to study environmental and geologic systems and processes

Content
1. Fundamentals of magnetism
2. Magnetic mineralogy
3. Measurement techniques
4. Time
5. Special Topics: Magnetoclimatology, mass transport, pollution monitoring, biophysics, magnetic properties of nanoscale materials

Lecture notes
Available on-line

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<th>Number</th>
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<tbody>
<tr>
<td>651-4109-00L</td>
<td>Geothermal Energy</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>K. F. Evans, P. Bayer, M. O. Saar</td>
</tr>
</tbody>
</table>

Abstract
The course will introduce students to the general principles of Geothermics and is suitable for students who have a basic knowledge of Geoscience or Environmental Science (equivalent of a Bachelor degree).

Objective
To provide students with a broad understanding of the systems used to exploit geothermal energy in diverse settings.

This course is a general introduction to the methods of seismic hazard analysis. The basic theory describing the flow of heat in the shallow crust will be covered, as will the methods used to measure it. Petrophysical parameters of relevance to Geothermics, such as thermal conductivity, heat capacity and radiogenic heat productivity, are described with the laboratory and borehole measurement techniques used to estimate their values. The focus will then shift towards the exploitation of geothermal heat at various depths and temperatures, ranging from electricity and heat production in various types of deep geothermal systems (including high and medium temperature hydrothermal systems, and Engineered Geothermal Systems at depths of 5 km or more), to ground-source heat pumps installed in boreholes at depths of a few tens to hundreds of meters for heating domestic houses.

The subjects covered are as follows:

Week 1: Introduction. Earth's thermal structure. Conductive heat flow
Week 3: Temperature measurement. Hydrothermal reservoirs & well productivity
Week 4: Hydrological characterisation of reservoirs. Drilling. Optimised systems
Week 5: Petrothermal or Engineered Geothermal Systems
Week 6: Low-enthalpy systems 1
Week 7: Low-enthalpy systems 2.

Lecture notes: The script for each class will be available for download from the Ilias website no later than 1 day before the class.

### Lithosphere Structure and Tectonics

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<tbody>
<tr>
<td>651-4014-00L</td>
<td>Seismic Tomography</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Kissling, T. Diehl, G. Hetényi</td>
</tr>
</tbody>
</table>

**Abstract**
Seismic tomography is the science of interpreting seismic measurements (seismograms) to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it, to gain information about the Earth.

**Literature**

### Tectonics

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<tbody>
<tr>
<td>651-3521-00L</td>
<td>Tectonics</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>J.P. Burg, E. Kissling</td>
</tr>
</tbody>
</table>

**Abstract**
Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

**Objective**
Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Assessment of mechanisms responsible for plate movements (the Earth as a heat transfer machine, dynamics of earth mantle, plate driving forces) and subsequent large-scale structures (oceanic basins and cycle of the oceanic lithosphere, convergence and mountain systems and continental growth, etc) through theoretical and experimental information. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

**Content**

**Lecture notes**
Detailed scriptum in digital form and additional learning modules (www.lead.ethz.ch) available on the intranet.

**Literature**

### Earthquake Seismology

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<tbody>
<tr>
<td>651-4021-00L</td>
<td>Engineering Seismology</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>D. Fäh, J. Burjanék</td>
</tr>
</tbody>
</table>

**Abstract**
This course is a general introduction to the methods of seismic hazard analysis. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties.

**Objective**
This course is a general introduction to the methods of seismic hazard analysis.

**Content**
In the course it is explained how the disciplines of seismology, geology, strong-motion geophysics, and earthquake engineering contribute to the evaluation of seismic hazard. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties. The course includes the discussion related to Intensity and macroseismic scales, historical seismicity and earthquake catalogues, ground motion parameters used in earthquake engineering, definitions of the seismic source, ground motion attenuation, site effects and microzonation, and the use of numerical tools to estimate ground motion parameters, both in a deterministic and probabilistic sense.

During the course recent earthquakes and their impacts are discussed and related to existing hazard assessments for the areas of interest.

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<tbody>
<tr>
<td>651-4103-00L</td>
<td>Earthquakes Source Physics</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Wiemer</td>
</tr>
</tbody>
</table>
1. Plate Tectonics before Space Geodesy.

The course is sub-divided in two parts:

**FIRST PART**
- Introduction: Definition of earthquake, faults, elastic rebound theory, source parameters definition.
- Introduction to elastodynamic: strain, stress, equation of motion.
- Mathematical description of the source: Representation theorem, earthquakes as point sources, moment-tensor derivation, source spectra.
- Earthquakes on extended faults: Kinematic earthquake characterization, kinematic source inversion

**SECOND PART**
- Earthquake source dynamics: Introduction to Linear Elastic Fractures mechanics, the state of stress and friction models,
- Energy partition during Earthquake
- Numerical simulation of shear earthquake rupture: Fault representation methods, elastodynamic coupled to frictional sliding.
- Identifying source-dominant ground motion phenomena
- Numerical exercise to model earthquake rupture dynamic

**Lecture notes**
Course notes will be made available on a designated course web site several days in advance of each lecture. No single script of book will be distributed or recommended as the material is compiled from several text books and the recent literature.

**Literature**
- Principles of Seismology by A. Udias, Cambridge University Press (January 13, 2000) ($140): easier to understand than Aki & Richards, less comprehensive
- An Introduction to Seismology, Earthquakes and Earth Structure by S. Stein and M. Wyssession, Blackwell Science; 1st edition (September 2002) ($96), very nice and comprehensive, not very theoretical
- Geophysical Geodesy

**Prerequisites / notice**
- The course will be evaluated in four parts, from a two hours final exam at the end of the course, a final presentation which will be based on a paper-study from the relevant recent literature, a writing report of a computer exercise and homework delivered during the course. The course will be worth 3 credit points, and a satisfactory total grade (4 or better averaged from the four evaluation parts) is needed to obtain 3 CPs. The final writing exam has a weight of 40% and the other three has a weight of 60% (each contributing 20% of the total grade).
- The course will be given entirely in English.

Course pre-requisites: standard "higher maths for physicists" (i.e. linear algebra, calculus, ODE's, PDE's, Fourier-Transforms, some probability theory); useful but not mandatory courses would be "Inverse Theory in Geophysics" and general geophysics courses (i.e. seismo-tectonics, seismic waves, introduction to geophysics).

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### Glaciology

**Data:** 06.12.2018 13:04  
**Autumn Semester 2015**  
**Page 523 of 1432**
ECTS
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system.

Hours
M. Funk
Cryosphere
Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff.

Basics in physical glaciology
Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

Prerequisites / notice
Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Lecture notes
Handouts are available

Literature
Relevante Literatur wird während der Vorlesung angegeben.

http://people.ee.ethz.ch/~luethim/teaching.html
Studium aktueller und klassischer Arbeiten der glaziologischen Forschung

Lecture notes
benefited Unterlagen werden im Verlauf der Veranstaltung abgegeben

Autumn Semester 2015

Data: 06.12.2018 13:04
Page 524 of 1432
Objective
Besuch von Fossilvorkommen im In- und Ausland, um die Erhaltung der Fossilien, die fazielle Ausbildung und die Stratigraphie der fossilführenden Schichten kennenzulernen und zu diskutieren sowie gegebenenfalls Fossilien zu sammeln.

Content

651-4058-00L Basics of Palaeobotany (University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO280

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
The course "Basics in Palaeobotany" gives an overview on the evolution and palaeobiology of plants and their relevance for the reconstruction of past environments.

Objective
On successful completion of the module, the students should be able to explain how plants are preserved in the fossil record, to describe the morphology of plant mega fossils, and of spores and pollen. They can describe how plant fossils can be used for reconstructing palaeoenvironments. Students should be able to explain the interactions between evolution of plants, climate and physical environment and they will be able to integrate the dimension of geological time into their understanding of biological events.

Content
- Preservation of plants in the fossil record.
- First evidence for plants on Earth
- The conquest of the continents by plants
- Major adaptation and innovations leading to the present plant diversity
- The evolution and morphology of the major plant groups
- Plant associations through geological time and their palaeogeographic and stratigraphic relevance
- Mass extinctions and the fossil plant record
- Interaction between past vegetation and climate
- The relevance of plant microfossils for reconstruction of palaeoclimate and palaeoecology

Geographic Information Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4267-00L</td>
<td>Specializing in Geographic Information Science V (University of Zürich)</td>
<td>O</td>
<td>5</td>
<td>2V+2U</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Remote Sensing

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4263-00L</td>
<td>Remote Sensing and Geographic Information Science V (University of Zürich)</td>
<td>O</td>
<td>5</td>
<td>2V+5U</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Mind the enrolment deadlines at UZH:
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<table>
<thead>
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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4269-00L</td>
<td>Specialisation in Remote Sensing: Spectroscopy of the Earth System (University of Zurich)</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Prerequisite: Remote Sensing Methods (UZH Module Code: GEO371)

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4257-00L</td>
<td>Specialisation in Remote Sensing: SAR and LIDAR (University of Zurich)</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Prerequisite: Remote Sensing Methods (UZH Module Code: GEO371)

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Modules from the Geology Major

Choice from Geology Restricted Choice Modules

Modules from the Engineering Geology Major

Choice from Engineering Geology Required Modules

Modules from the Geophysics Major
### Modules from the Mineralogy & Geochemistry Major

#### Choice from the Mineralogy & Geochemistry Restricted Choice Modules

### Major in Engineering Geology

#### Compulsory Modules

#### Engineering Geology Fundamentals

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4025-00L</td>
<td>Rock Mechanics and Rock Engineering</td>
<td>O</td>
<td>4 credits</td>
<td>4V+2U</td>
<td>F. Amann, V. Gischig, M. Perras</td>
</tr>
</tbody>
</table>

**Abstract**
This course focuses on the principles (fundamentals) and basic concepts of rock mechanics and rock engineering (e.g. tunnelling, rock slope stability).

**Objective**
The course aims to introduce the fundamentals and basic concepts of rock mechanics and generic rock engineering. The student shall understand how rocks behave at different scales, under various artificial loads and in the shallow subsurface (a few km below ground). The link between rock mechanics, geology, hydrogeology and tectonics (i.e. the conditions under which the rock formed) will be clearly established.

The student shall understand basic principles of rock mechanics and rock engineering. In addition, the student shall learn how to carry out laboratory tests, to interpret these tests and to apply the results from lab and field investigations to simple engineering problems. This knowledge is required for subsequent integration courses (Landslide Analysis and Hazard Mitigation; Engineering Geology of Underground Excavations).

**Content**
This course focuses on the principles (fundamentals) and basic concepts of rock mechanics and generic rock engineering. The behavior of different rock types is studied with laboratory investigations which are linked to the theoretical aspects discussed in lectures and applied in exercises. The course is compulsory for the MSc Eng Geol. The applications of rock mechanical principles and rock engineering methods are extensively covered in subsequent courses.

**Lecture notes**
Written course documentation available on our homepage: www.engineeringgeology.ethz.ch

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4033-00L</td>
<td>Soil Mechanics and Foundation Engineering</td>
<td>O</td>
<td>4 credits</td>
<td>3V+2U</td>
<td>M. Perras, A. Wolter, M. Stolz</td>
</tr>
</tbody>
</table>

**Abstract**
The course presents the principles of soil mechanics and soil behaviour characteristics and its applications in geotechnical structures and systems. It is based on more descriptive courses on Engineering Geology within the BSc Geol. Program and is a compulsory prerequisite for other courses within the MSc Eng. Geol. program.

**Objective**
Understanding the principles of soil behaviour and the fundamentals of geotechnical practices in soils.
Ability to communicate with geotechnical engineers.

**Content**
Soil Mechanics:
- Fundamental concepts of strength and deformation of different soils.
- Introduction to geotechnical calculations
- Significance of (ground)water

Geotechnical Engineering in Soils:
- Evaluation of geotechnical scenarios, handling of forecast uncertainties, relation of soil properties and soil composition, interactions between soil and building,
- standard construction methods in soils (foundations, slopes, dams and levees),
- requirements for the geotechnical prognosis

**Prerequisites / notice**
Courses must be completed:
- Introduction to Engineering Geology (BSc level)
- Introduction to Groundwater
- Sedimentology and Quaternary deposits
- Principles of Physics

Courses recommended:
- Eng Geol Site Investigations
- Eng Geol Field Course I (soils)
- Clay Mineralogy

**Lecture notes**
This lecture is supported by the textbook: "Geotechnical Engineering" by Donald P. Coduto, 2nd edition, 2011; ISBN-13: 978-0-13-135425-8

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4023-00L</td>
<td>Groundwater</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>M. O. Saar, X.Z. Kong</td>
</tr>
</tbody>
</table>

**Abstract**
The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

**Objective**
a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.
b) Students are able to formulate simple practical flow and transport problems.
c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.
d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.
1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.

2. Flow equation. The generalized Darcy law.

3. The water balance equation.


5. Analytical solutions to flow problems I

6. Analytical solutions to flow problems II

7. Finite difference solution to flow problems.


12. Analytical solutions to transport problems I.

13. Analytical solutions to transport problems II


Script in English is planned.

B. Oddsson

Courses for this Module take place in spring semester.

The Industrial Internship of the Eng Geol Major should take place in the second MSc year after consultation with Dr. Björn Oddsson. Detailed regulations of this practical are published on the Eng Geol Website.
The industry practical is supervised both from the industry partner and ETH and consists of technically and/or scientifically challenging work in the engineering geology domain. The regular duration of the practical is 2.5 month. The practical is is pre-defined in a work plan and concluded with a report written by the student.

The goals of the industry practical are to become familiar with technical, economic, legal and communication issues of real-life work in private industry or technical administration.

**Major in Geophysics**

**Compulsory Modules Geophysics**

**Geophysical Methods I**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4005-00L</td>
<td>Geophysical Data Processing</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>C. V. Cauzzi</td>
</tr>
</tbody>
</table>

**Abstract**

This course presents fundamental digital signal processing and filter theory with a focus on geophysical applications.

**Objective**

The goal of the course is to provide an understanding of the principles of digital signal processing and filter theory. Form: two hours lecture with two hours of computer based exercises per week over 7 weeks.

**Content**

- Analog-digital conversion: dynamic range and resolution; Dirac-impulse, step function; Laplace transformation; Z-transformation; Differential equations of linear time-invariant systems; Examples: seismometer and RC-filter; Impulse response and transfer function; Frequency selective filters: example Butterworth filters; Digital filters: impulse invariance and bilinear transformation; Inverse filters; Response spectra.

**Lecture notes**

Lecture notes will be made available for download from the website of the course.

**Literature**

The class follows no single book. A list of relevant texts will be given in class.

**Prerequisites / notice**

Students must bring their own laptop in class for Matlab exercises.

**651-4241-00L**

**Numerical Modelling I and II: Theory and Applications**

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4241-00L</td>
<td>Numerical Modelling I and II</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>T. Gerya</td>
</tr>
</tbody>
</table>

**Abstract**

In this 13-week sequence, students learn how to write programs from scratch to solve partial differential equations that are useful for Earth science applications. Programming will be done in MATLAB and will use the finite-difference method and marker-in-cell technique. The course will emphasise a hands-on learning approach rather than extensive theory.

**Objective**

The goal of this course is for students to learn how to program numerical applications from scratch. By the end of the course, students should be able to write state-of-the-art MATLAB codes that solve systems of partial-differential equations relevant to Earth and Planetary Science applications using finite-difference method and marker-in-cell technique. Applications include Poisson equation, buoyancy driven variable viscosity flow, heat diffusion and advection, and state-of-the-art thermomechanical code programming. The emphasis will be on commonality, i.e., using a similar approach to solve different applications, and modularity, i.e., re-use of code in different programs. The course will emphasise a hands-on learning approach rather than extensive theory, and will begin with an introduction to programming in MATLAB.

**Content**

A provisional week-by-week schedule (subject to change) is as follows:

- **Week 1**: Introduction to the finite difference approximation to differential equations. Introduction to programming in Matlab. Solving of 1D Poisson equation.
- **Week 2**: Direct and iterative methods for obtaining numerical solutions. Solving of 2D Poisson equation with direct method. Solving of 2D Poisson equation with Gauss-Seidel and Jacobi iterative methods.
- **Week 3**: Solving momentum and continuity equations in case of constant viscosity with stream function/vorticity formulation. Weeks 4: Staggered grid for formulating momentum and continuity equations. Indexing of unknowns. Solving momentum and continuity equations in case of constant viscosity using pressure-velocity formulation with staggered grid.
- **Week 5**: Conservative finite differences for the momentum equation. “Free slip” and “no slip” boundary conditions. Solving momentum and continuity equations in case of variable viscosity using pressure-velocity formulation with staggered grid.
- **Week 6**: Advection in 1-D: Eulerian methods. Marker-in-cell method. Comparison of different advection methods and their accuracy.
- **Week 9**: Solving 2D heat conservation equation in case of constant thermal conductivity with explicit and implicit approaches.
- **Week 10**: Solving 2D heat conservation equation in case of variable thermal conductivity with implicit approach. Temperature advection with markers. Creating thermomechanical code by combining mechanical solution for 2D buoyancy driven flow with heat diffusion and advection based on marker-in-cell approach.
- **Week 11**: Subgrid diffusion of temperature. Implementing subgrid diffusion to the thermomechanical code.
- **Week 12**: Implementation of radioactive, adiabatic and shear heating to the thermomechanical code.
- **Week 13**: Implementation of temperature-, pressure- and strain rate-dependent viscosity, temperature- and pressure-dependent density and temperature-dependent thermal conductivity to the thermomechanical code. Final project description.

**Literature**

Taras Gerya, Introduction to Numerical Geodynamic Modelling, Cambridge University Press 2010

**Geophysical Methods II**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4001-00L</td>
<td>Geophysical Fluid Dynamics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>J. A. R. Noir</td>
</tr>
</tbody>
</table>

**Abstract**

Fluid mechanics is one of the fundamental building blocks of modern geophysics. This course aims to provide the students with the basics tools used in fluid dynamics studies of geophysical-astrophysical problems. The course is a combination of lectures, exercises and demo experiments to present the same concepts in various forms.

**Objective**

The goal of this course is to develop familiarity with basic fluid dynamical concepts relevant to geophysical and astrophysical problems.

**Content**

1. Basic concepts.
3. Dynamical similarity and scale analysis.
4. The inviscid approximation.
5. Streamlines-Streamfunctions.
6. Elements of boundary layer theory - Application to viscous boundary layer.
7. Vorticity-Concept and Examples.
8. Introduction to rotating fluid.
9. Viscous boundary layer in rotating fluid.
10. Non-rotating thermal convection.
11. Introduction to rotating thermal convection.
The course will guide students in learning about solutions of partial differential equations arising in connection with various physical problems. Special attention will be paid to the solutions of Laplace's equation in spherical and cylindrical coordinates. In addition the basics of vector calculus will be discussed in order to support Geophysical Fluid Dynamics and Potential Field Theory courses.

Content

A provisional week-by-week schedule (subject to change) is as follows:

Week 1: The continuity equation
Theory: Definition of a geological medium as a continuum. Field variables used for the representation of a continuum. Methods for definition of the field variables. Eulerian and Lagrangian points of view. Continuity equation in Eulerian and Lagrangian forms and their derivation.
Exercise: Computing the divergence of velocity field.

Week 2: Density and gravity
Exercise: Computing density, thermal expansion and compressibility from an equation of state.

Week 3: Stress and strain
Theory: Deformation and stresses. Definition of stress, strain and strain-rate tensors. Deviatoric stresses. Mean stress as a dynamic (non-holostatic) pressure. Stress and strain rate invariants.
Exercise: Analysing strain rate tensor for solid body rotation.

Week 4: The momentum equation
Exercises: Computing velocity for magma flow in a channel.

Week 5: Viscous rheology of rocks
Theory: Solid-state creep of minerals and rocks as the major mechanism of deformation of the Earth's interior. Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws.
Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

Week 6: The heat conservation equation
Exercise: steady temperature profile in case of channel flow.

Week 7: Elasticity and plasticity

GRADING will be based on homeworks (30%) and oral exams (70%).

Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS
Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

do not use the questions from previous exams.

Exercise notes

Current lecture notes and homeworks will be found during the course at www.epm.geophys.ethz.ch/~kuvshinov/Lectures

Literature

Taras Gerya Introduction to Numerical Geodynamic Modelling Cambridge University Press, 2010

Restricted Choice Modules Geophysics

Seismology

The course is a general introduction to the theory of seismic wave propagation. It explains the principles and assumptions used in seismology. It provides the tools to solve basic seismological problems.

The course is a general introduction to the theory of seismic wave propagation.

The course explains the principles and assumptions used in seismology. It provides the tools to solve basic seismological problems. The course includes the theorems in dynamic elasticity, the formulation with potentials, Greens function, elastic waves from point dislocation sources, moment tensors, 1D, 2D, and 3D wave propagation problems, reflection and transmission at plane boundaries, and surface waves in a vertically heterogeneous medium.

**651-4015-00L Seismotectonics**

*Abstract*

If you're interested in knowing more about the relationship between seismicity and plate tectonics, this is the course for you. (If you're not that interested, but yr program of study requires that you complete this course, this is also the course for you.)

*Objective*

By the conclusion of this course, we hope that you:

- have a solid understanding of stress and strain and tensor representations;
- have a feeling for what rheology is and why it is important;
- have a more sophisticated understanding of the relationship b/w plate tectonics and eqks;
- understand eqk source representations of varying complexity;
- understand eqks in the context of different tectonic settings;
- understand why we can't predict eqks; and
- understand that "modern science is... a set of research directions rather than a collection of nuggets of established truth."

*Content*

To begin our series of 14 meetings, we will review fundamentals of continuum mechanics and tensor analysis; our goal is to help you understand deformation from the scale of cornstarch in the classroom to the scale of plate tectonics. We will tell you about several ways to approximate an earthquake source; we'll present these in order of increasing sophistication. We'll discuss a currently-popular theory to explain earthquake triggering. We'll talk about the conceptual connections between earthquakes and tectonic deformation. You will enjoy (at least) two computer exercises.

Discussed: stress and deformation in the Earth; stress and strain tensors; rheology and failure criteria; fault stresses, friction and effects of fluids; stable and unstable sliding; earthquake focal mechanisms; relationship between stress fields and focal mechanisms; seismic moment and moment tensors; relationship between moment- and deformation tensors; crustal deformation from seismic, geologic, and geodetic observations; earthquake stress drop, scaling, and source parameters; earthquake induced stress changes; global earthquake distribution; current global earthquake activity; different seismotectonic regions; examples of earthquake activity in different tectonic settings, such as in subduction zones, California, the Mediterranean, and in Switzerland.

**Lecture notes**

TBA

**Literature**


**Prerequisites / notice**

You should have at least a foggy recollection of calculus.

**651-4021-00L Engineering Seismology**

*Abstract*

This course is a general introduction to the methods of seismic hazard analysis. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties.

*Objective*

This course is a general introduction to the methods of seismic hazard analysis.

*Content*

In the course it is explained how the disciplines of seismology, geology, strong-motion geophysics, and earthquake engineering contribute to the evaluation of seismic hazard. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties. The course includes the discussion related to Intensity and macroseismic scales, historical seismicity and earthquake catalogues, ground motion parameters used in earthquake engineering, definitions of the seismic source, ground motion attenuation, site effects and microzonation, and the use of numerical tools to estimate ground motion parameters, both in a deterministic and probabilistic sense.

During the course recent earthquakes and their impacts are discussed and related to existing hazard assessments for the areas of interest.

**Lecture notes**

TBA

**Literature**

It is recommended but not mandatory to buy one of these books:

- Fundamental Planetary Science, by Jack J. Lissauer & Imke de Pater (paperback), Cambridge University Press, 2013. (books.ch Fr64.90, amazon.co.uk £35.00, amazon.de €38.61, amazon.com $49.26).

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**Physics of the Earth’s Interior**

*Courses for the Module Physics of the Earth’s Interior take place in Spring Semester.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4010-00L</td>
<td>Planetary Physics and Chemistry</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Tackley</td>
</tr>
</tbody>
</table>

*Abstract*

This course aims to give a physical understanding of the formation, structure, dynamics and evolution of planetary bodies in our solar system and also apply it to ongoing discoveries regarding planets around other stars.

*Objective*

The goal of this course is to enable students to understand current knowledge and uncertainties regarding the formation, structure, dynamics and evolution of planets and moons in our solar system, as well as ongoing discoveries regarding planets around other stars. Students will practice making quantitative calculations relevant to various aspects of these topics through weekly homeworks.

The following gives an overview of the course content and approximate schedule (subject to change).

<table>
<thead>
<tr>
<th>Hours</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Introduction</td>
</tr>
<tr>
<td>3-4</td>
<td>Orbital dynamics and Tides</td>
</tr>
<tr>
<td>5-6</td>
<td>Solar heating and Energy transport</td>
</tr>
<tr>
<td>7-8</td>
<td>Planetary atmospheres</td>
</tr>
<tr>
<td>9-10</td>
<td>Planetary surfaces</td>
</tr>
<tr>
<td>11-12</td>
<td>Planetary interiors</td>
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<tr>
<td>13-14</td>
<td>Asteroids and Meteorites</td>
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<tr>
<td>15-16</td>
<td>Comets</td>
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<td>17-18</td>
<td>Planetary rings</td>
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<tr>
<td>19-20</td>
<td>Magnetic fields and Magnetospheres</td>
</tr>
<tr>
<td>21-22</td>
<td>The Sun and Stars</td>
</tr>
<tr>
<td>23-24</td>
<td>Planetary formation</td>
</tr>
<tr>
<td>25-26</td>
<td>Exoplanets and Exobiology</td>
</tr>
<tr>
<td>27-28</td>
<td>Review</td>
</tr>
</tbody>
</table>

**Lecture notes**

Slides and scripts will be posted at the moodle site:https://moodle-app2.let.ethz.ch/course/view.php?id=1658

**Literature**

Fundamental Planetary Science, by Jack J. Lissauer & Imke de Pater (paperback), Cambridge University Press, 2013. (books.ch Fr64.90, amazon.co.uk £35.00, amazon.de €38.61, amazon.com $49.26).


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**Applied Geophysics**

*The compulsory Courses for the Module Applied Geophysics take place in Spring Semester. One additional elective course of at least 3KP has to be
Students will learn to understand the use of non-metallic mineral resources from a geological and mineralogical point of view as well as economic, strategic and environmental aspects.

2G

Applied Mineralogy and Non-Metallic Resources I

Type: O
ECTS: 3 credits
Hours: 2G

Lecturers: J. Connolly

Selected handouts will be made available in the lecture.


Title: Fundamental principles of X-ray diffraction

Lecturers: M. W. Schmidt, R. Kündig

Upon successful completion of this course students are able to:

- describe the principle of X-ray diffraction analysis
- carry out a qualitative and quantitative mineralogical analysis independently,
- critically assess the data,
- communicate the results in a scientific report.

Content: Setup and operation of X-ray diffractometers

Interpretation of powder diffraction data

Qualitative and quantitative phase analysis of crystalline powders (e.g. with Rietveld analysis)

Number of participants limited to 12.

Lecture notes: Selected handouts will be made available in the lecture.
Literature


Prerequisites / notice
The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data.

Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential.
The lecture course is limited to 12 participants.

651-4028-00L
Physical Properties of Minerals
O 3 credits 2G E. Reusser

Abstract
Physical properties of minerals, e.g. electrical properties, elasticistical properties are discussed. The effect of the crystal symmetry on the symmetry of physical properties as well as the mathematical formulation of the physical properties are major topics.

651-4223-00L
Phase Petrology
W 3 credits 2G L. Tajcmanová

Abstract
A comprehensive introduction to heterogeneous phase equilibria in the geosciences.

Objective
The aim of the course is to give insight into processes that lead to the formation of magmatic and metamorphic rocks.
The course will give an introduction to phase petrology and its application to magmatic and metamorphic systems. Further, the course will give an introduction to thermobarometry of mineral assemblages. The origin and interpretation of microstructures and chemical zonation in rocks will be discussed. We will also touch kinetics of rock forming processes and the role of fluids during the lectures.
The specific topics will involve:
Mineral reactions and chemical equilibrium in metamorphic and magmatic rocks, recalculations of rock and mineral analyses, mineral modes, P-T-X relations.

Content
The lecture course is limited to 12 participants.

651-4063-00L
X-ray Powder Diffraction
W 3 credits 2G L. M. Plötze

Abstract
In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.

Objective
Upon successful completion of this course students are able to:
- describe the principle of X-ray diffraction analysis
- carry out a qualitative and quantitative mineralogical analysis independently,
- critically assess the data,
- communicate the results in a scientific report.

Content
Fundamental principles of X-ray diffraction
Setup and operation of X-ray diffractometers
Interpretation of powder diffraction data
Qualitative and quantitative phase analysis of crystalline powders (e.g. with Rietveld analysis)

Lecture notes
Selected handouts will be made available in the lecture

Literature

Prerequisites / notice

1) the blue book by F Spear 1993 Metamorphic phase equilibria and pressure-temperature-time paths. MSA Mongraph

2) Principles of Metamorphic Petrology; Ron H. Vernon, Geoffrey Clarke

▌▌▌ Petrology and Volcanology

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-4233-00L</td>
<td>Geotectonic Environments and Deep Global Cycles</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. W. Schmidt, P. Ulmer</td>
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</table>

Abstract
This course addresses master students interested in integral view of processes operating in various tectonic environments, most specifically divergent and convergent plate margins

651-4063-00L | X-ray Powder Diffraction | W    | 3    | 2G    | L. M. Plötze      |

Abstract
Number of participants limited to 12.

In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.

Objective
Upon successful completion of this course students are able to:
- describe the principle of X-ray diffraction analysis
- carry out a qualitative and quantitative mineralogical analysis independently,
- critically assess the data,
- communicate the results in a scientific report.

Content
Fundamental principles of X-ray diffraction
Setup and operation of X-ray diffractometers
Interpretation of powder diffraction data
Qualitative and quantitative phase analysis of crystalline powders (e.g. with Rietveld analysis)

Lecture notes
Selected handouts will be made available in the lecture

Literature

Prerequisites / notice

1) the blue book by F Spear 1993 Metamorphic phase equilibria and pressure-temperature-time paths. MSA Mongraph

2) Principles of Metamorphic Petrology; Ron H. Vernon, Geoffrey Clarke

▌▌▌ Mineral Resources

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<tr>
<th>Number</th>
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<tr>
<td>651-4037-00L</td>
<td>Ore Deposits I</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>C. A. Heinrich, P. Lecumberri Sanchez</td>
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</table>

Abstract
Principles of hydrothermal ore formation, using base metal deposits (Cu, Pb, Zn) in sedimentary basins to explain the interplay of geological, chemical and physical factors from global scale to sample scale. Introduction to orhomagmatic ore formation (mostly Cr, Ni, PGE),

Objective
Understanding the fundamental processes of hydrothermal and magmatic ore formation, recognising and interpreting mineralised rocks in geological context.

Content
(a) Principles of hydrothermal ore formation: base metal deposits in sedimentary basins. Practical classification of sample suites by genetic ore deposit types
Mineral solubility and ore deposition, principles & thermodynamic prediction using activity diagrams. Stable isotopes in ore-forming hydrothermal systems (O, H, C, S) Driving forces and structural focussing of hydrothermal fluid flow
(b) Introduction to orhomagmatic ore formation. Chromite, Ni-Cu sulphides and PGE in layered mafic intrusions. Distribution coefficients between silicate and sulphide melts. Carbonatites and pegmatite deposits.

Lecture notes
Notes handed out during lectures

Literature
Extensive literature list distributed in course
Applied Mineralogy and Non-Mineral Resources I

**Objective**

Students will learn to understand the use of non-metallic mineral resources from a geological and mineralogical point of view as well as from industrial, technical and strategical (political) point of view. Environmental aspects on the worldwide use of non-metallic mineral resources are discussed. A special focus will be given on the situation in Switzerland.

**Content**

Teaching, case-studies and excursions (e.g. raw-material industry).

Course “Applied mineralogy and non-metallic resources I” (autumn/winter semester):

- Non-metallic resources. Occurrences, geology, extraction, properties, fabrication and use. Industrial aspects, (new) technologies, market, stock, situation, reserves & resources, trends and development, environmental aspects, law.
  
- Chapters: e.g. coal/uranium; coal, graphite, diamond, fullerene; oil/gas (oil- and tarsands, oil-shits); phosphates/nitrates; aluminum (bauxite, corundum); salt; carbonates; titanium; clay and clay minerals; sulphur; gypsum/anhydrite; fluoride; asbestos; talc; micas; rare earth elements.

Course “Applied mineralogy and non-metallic resources II” (fall/summer semester):

  
- Chapters: e.g. Stone industry - technical aspects of building stones, properties, weathering, treatment, quarries, products. Crushed stones - quarries, products, planning, environment. Gravel an sand - resources/reserves, environment (protection/law), alternative products (substitution). Cement and concrete (geological resources, prospection, fabrication, environment).

**Lecture notes**

Will be given according to the lessons. Partially e-learning of the materials.

**Literature**


Resource Economics and Mineral Exploration

**Objective**

Practical understanding of the procedure of exploring a mineral prospect, based on geological analysis, exploration by drilling, resource calculation of tonnage and grade as a basis for economic evaluation for reporting to investors.

**Content**

This block course in will comprise 4 half-day lectures and a series of practical exercises from selection of a mineral property to discovery of mineral resources and their valuation. Teams are formed as Limited Partnership companies that have to select and bid for a mineral property offered during an auction. Each company has the same nominal budget. The highest bidder purchases the selected property, others need to purchase the remaining properties during an auction. Justification for selecting the property is justified in a report. The companies must interpret the geological of their mineral property to prepare a diamond drill program to discover and, eventually, delineate the mineral resources. This drill program is presented in a report prior to drilling. Drilling in the tri-dimensional matrix of the property is simulated using the software FOREUR, until budget lapse. The companies must select drill intervals for chemical analysis to document the extent and composition of the discovered mineralization. Portions of the mineral rights can be traded for capital between the companies. An estimate of the tonnage and grade of the discovered resource is prepared using geometrical methods and GIS software (ex. ArcGIS). The ground value of the resource is estimated by a computation of the Net Smellet Return at current metal prices. The results of the exploration program are presented in a comprehensive report.

**Lecture notes**

Handouts for background information and a computer simulation program for the case-study exercise will be provided. Participants must bring a Windows-based laptop computer.

**Prerequisites / notice**

Prerequisites: Knowledge of mineral deposit-type characteristics is useful (orogenic gold, Cu-Zn VMS, Ni-Cu-PGE); at least “Ressourcen der Erde”, or adequate knowledge of mineral deposits acquired by preparatory reading. Basic knowledge of ArcGIS software is important to produce maps and sections required in reports. Training exercises and tutorials will be provided in advance to prepare for the course. Taught biennially in collaboration with University of Geneva.

This course is co-organised by ETH Zurich (Prof. C. Heinrich) and University of Geneva (Prof. L. Fontbote)

Numerical Modelling of Ore Forming Hydrothermal Processes

**Objective**

Learn how to use the simulation programs HYDROTHERM and HCh to explore how hydrothermal systems work.

**Content**

Introduction to computer tools for the simulation of hydrothermal processes: HYDROTHERM for fluid flow simulations, HCh for thermodynamic modeling. While learning the respective computer programs is an essential part of the course, the emphasis will be on using these tools to learn how the physics and chemistry of hydrothermal system actually work.

**Lecture notes**

Computer programs and course material will be distributed during the course.

**Literature**


Objective
Practical ability to carry out a meaningful fluid or melt inclusion study in the fields of geochemistry, petrology or resource geology, involving problem definition, research planning, quantitative measurements using a combination of techniques, critical interpretation and correct documentation of results.

Lecture notes
Handouts with extensive list of primary literature available

Literature
Goldstein and Reynolds (1994): CD available for in-house use

Geochemistry

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<td>651-4227-00L</td>
<td>Planetary Geochemistry</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Schönbachler, H. Busemann, D. L. Cook</td>
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</table>

Abstract
Formation and evolution of the solar system with a geochemical perspective

Objective
To understand the formation and evolution of the solar system from a geochemical perspective

Content
The sun and solid objects in the solar system (planets, comets, asteroids, meteorites, interplanetary dust) are discussed with a geochemical perspective. What does their present-day composition tell us about the origin and evolution of the solar system? The lecture first introduces the basic facts of the terrestrial and giant planets, as well as comets and asteroids, as mainly gained from modern planetary missions. The chemical and isotopic composition of meteorites, being the most primitive material available for study, is a further major topic.

Lecture notes
available electronically

651-4049-00L
Conceptual and Quantitative Methods in Geochemistry

Abstract
This course will introduce some of the main quantitative methods available for the quantitative treatment of geochemical data, as well as the main modelling tools. Emphasis will both be on conceptual understanding of these methods as well as on their practical application, using key software packages to analyse real geochemical datasets.

Objective
Development of a basic knowledge and understanding of the main tools available for the quantitative analysis of geochemical data.

Content
The following approaches will be discussed in detail: major and trace element modelling of magmas, with application to igneous systems; methods and statistics for calculation of isochrons and model ages; reservoir dynamics and one-dimensional modelling of ocean chemistry; modelling speciation in aqueous (hydrothermal, fresh water sea water) fluids.

Lecture notes
available electronically

Prerequisites / notice
Pre-requisite: Geochemistry (651-3400-00L), Isotope Geochemistry and Geochronology (651-3501-00L).

651-4229-00L
Advanced Geochronology

Objective
The purpose of this lecture is to provide a comprehensive overview of: a) the different radiometric methods in Geology, the different dating tasks and the constraints put by the complexity of natural systems, including dating by cosmogenic nuclides, b) the various analytical tools available today for radiometric dating, their advantages and disadvantages, c) the use of noble gases in Geochemistry and d) detailed description of case studies, as examples of approach of a number of geological problems and interpretation of the data.
The content of this lecture is summarised as follows:

Anthi Liati:
- Ion microprobes - U-Pb SHRIMP dating (zircon, sphene, rutile, monazite)
- Dating metamorphic rocks
- Combined geochronology and petrology subduction and exhumation rates
- Tracing the timing of mantle and crustal events via zircon-dating in mantle xenoliths: Two case studies: South Namibia, Kilbourne Hole (New Mexico)

Giuditta Fellin:
- Fission track dating (two hours lecture)
- U-Th/He dating
- Visit of the laboratories

Henner Busemann:
- Noble gas geo- and cosmochemistry
- Surface exposure dating with cosmogenic nuclides
- carbon-14 dating and U-Th-He thermochronology
- Visit of the radiogenic and noble gas isotope laboratories of IGMR

Albrecht von Quadt:
- Analytical tools and applications to radiogenic isotopes (basics about TIMS, LA-ICP-MS-MC)
- Dating magmatic rocks and ore deposits (porphyry, epithermal Cu-Au-(Mo) deposits)
- U-Pb, Re-Os, Pb-Pb methods - Hi tracing of zircons
- Geochronology and geochemistry of magmatic systems

Marcel Guillong:
- LA-ICP-MS as the method of choice for dating, in comparison to other methods (Ion-probe, TIMS, ...)
- Data reduction in LA-ICP-MS: from measured counts per seconds to the final age of a sample, with hands on example.
- The challenge to date very young Zircons, with an example from Kos.

Ben Ellis:
- Ar-Ar dating techniques
- Ar-Ar dating of volcanic rocks

Lecture notes
Script (for part of the lecture), partly power point presentations (in the web) and partly copies of power point transparencies.

Literature

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651-4235-00L Marine Geology and Geochemistry W 3 credits 2G G. Bernasconi-Green

Abstract
Introduction to oceanographic methods and international research programs in marine geology and an overview of physical, chemical and biological processes in modern marine environments.

Objective
This course aims at giving an overview of oceanographic methods and an understanding of physical, chemical and biological processes in modern marine environments. This course will combine lectures and student participation. Student presentations are based on critical reading of research papers and integration of data and results from international oceanographic programs and ocean drilling.

Content
Specific topics will be chosen to examine processes of crustal formation, alteration, mass transfer and biological activity in mid-ocean ridge, continental margin and subduction zone settings, with consideration of data and new results obtained from international oceanographic programs and from DSDP, ODP and IODP drilling.

Student participation and discussions are based on critical reading of research papers, use of internet-based data, and web-based cruise results. Requirements to obtain credit points are oral or poster presentations and a short written summary of selected themes.

Lecture notes
No formal script will be distributed. Handouts will be given, where necessary. These will consist of the most important diagrams presented in the lectures. The students are expected to take their own notes and consult the literature for more details.

Literature
Lists of literature relevant to the selected topics will be handed out in the course.

This course is offered every 2 years.

651-4057-00L Climate History and Palaeoclimatology W 3 credits 2G G. Haug, A. Martinez-Garcia

Abstract
The course *Climate history and palaeoclimatology* gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimatic research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics- through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimatic archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.
Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.
Geological time, stratigraphy, geological archives, climate archives, paleoclimate proxies
Climate through geological time: "lessons from the past"
Cretaceous greenhouse climate
The Late Paleocene Thermal Maximum (PETM)
Cenozoic Cooling
Onset and Intensification of Southern Hemisphere Glaciation
Onset and Intensification of Northern Hemisphere Glaciation
Pliocene warmth
Glacial and Interglacials
Millennial-scale climate variability during glaciations
The last deglaciation(s)
The Younger Dryas

Holocene climate - climate and societies

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<tr>
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<td>Exoplanets and Exobiology</td>
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<td>27-28</td>
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<td>Review</td>
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</table>

Lecture notes
Slides and scripts will be posted at the moodle site: https://moodle-app2.let.ethz.ch/course/view.php?id=1658

Literature
It is recommended but not mandatory to buy one of these books:
Fundamental Planetary Science, by Jack J. Lissauer & Imke de Pater (paperback), Cambridge University Press, 2013. (books.ch Fr64.90, amazon.co.uk £35.00, amazon.de €38.61, amazon.com $49.26).

Open Choice Modules

Modules from the complete offerings of the Earth Science Program

Electives
Courses can be chosen from the complete offerings of the ETH Zurich and University of Zurich (according to prior agreement with the MSc Committee).

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<tr>
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<td>651-4233-00L</td>
<td>Geotectonic Environments and Deep Global Cycles</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. W. Schmidt, P. Ulmer</td>
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Colloquium Geophysics

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<td>Colloquium Geophysics</td>
<td>W</td>
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</table>
Abstract
This colloquium comprises geophysical research presentations by invited leading scientists from Europe and overseas, advanced ETH Ph.D. students, new and established ETH scientists with specific new work to be shared with the institute. Topics cover the field of geophysics and related disciplines, to be delivered at the level of a well-informed M.Sc. graduate/early Ph.D. student.

Objective
Attendants of this colloquium obtain a broad overview over active and frontier research areas in geophysics as well as opened questions. Invited speakers typically present recent work: Attendants following this colloquium for multiple terms will thus be able to trace new research directions, trends, potentially diminishing research areas, controversies and resolutions thereof, and thus build a solid overview of state and direction of geophysical research. Moreover, the diverse content and delivery style shall help attendants in gaining experience in how to successfully present research results.

651-1851-00L
Introduction to Scanning Electron Microscopy
W 1 credit 2G K. Kunze, L. Martin

Objective
Introduction in scanning electron microscopy and microanalysis. Obtain practical experience in operating a SEM.

Content

Lecture notes
Scripts and operation manuals are provided during the course.

Literature

Prerequisites / notice
Full day block course after the end of HS

651-0048-00L
Electron Microprobe Course
W 3 credits 4G E. Reusser

Objective

Content
Physical principles of electron optics, interaction of electrons with matter, production of X-rays, interaction of X-rays with matter. Detection of X-rays. Laboratory work in the field of Earth sciences.

Lecture notes
Kursunterlagen

Literature

Prerequisites / notice
7 full days.

Prerequisite: Analytical methods in Petrology and Geology (651-4055-00L).

Max. 8 participants (incl. PhD students and external participants).

- Restricted attendance. Register with E. Reusser.

327-0703-00L
Electron Microscopy in Material Science
W 4 credits 2V+2U H. Gross, R. Erni, S. Gerstl, F. Gramm, F. Krumreich, K. Kunze, R. A. Wepf

Objective

Content
Physical principles of electron optics, interaction of electrons with matter, production of X-rays, interaction of X-rays with matter. Detection of X-rays. Laboratory work in the field of Earth sciences.

Lecture notes
Kursunterlagen

Literature

Additional material will be provided by the lecturers.

3651-3541-00L
Exploration and Environmental Geophysics
W 4 credits 3V F. Brogini, J. Doetsch

Objective
Overview and understanding of the most important geophysical methods: Potential field methods (Gravimetrics and Magnetics), Electrical and electromagnetic methods, Refraction and reflection seismics, Georadar. Discussion of survey design, sources and receivers and data processing.

Content

Lecture notes
Available through eDoz/ILIAS.

Additional material will be provided by the lecturers.

Literature

651-4086-00L
Experimental Methods in Petrology
W 3 credits 2P C. Liesbke

Objective
Overview of the most common experimental methods employed in petrology to determine thermodynamic and physical properties and phase equilibria of minerals, mineral assemblages, magmas and fluids. The basic principals of low, moderate, high and ultrahigh pressure devices are discussed combined with an introduction into the synthesis of starting materials and the evaluation of run products.
This course will provide the basics of experimental petrology. The principal goals are the acquisition of basic knowledge about experimental equipment employed in petrology and the design and setup of an experimental study targeted to obtain quantitative data on phase relations, thermodynamic, kinetic and rheologic properties of earth materials as well as the examination, analysis and evaluation of experiments. At the end of the course, the participants should be able to evaluate experimental data independently and design appropriate experiments on their own.

The course 'Experimental methods in petrology' covers the following subjects:

1. Introduction and historical summary of experimental petrology
2. Experimental methods at ambient pressure (1 bar) with practical exercise to determine the free energy of formation of wustite (FeO)
3. Experimental buffering techniques (phase rule, buffering of partial pressures of gases and supercritical fluids, buffering of mixed volatile phases at elevated pressures, buffering of activities and solid-solid solutions in solid phases
4. Experimental methods at moderate pressures: externally (cold seal) and internally (HPV) heated gas-pressures apparatus with practical demonstration/exercise
5. High-pressure solid-media experimental techniques (piston cylinders)
6. Ultrahigh-pressure experimental techniques (multi-anvil apparatus, diamond-anvil-cells (DAC)
7. Evaluation of petrologic experiments (preparation of run products, analytical and spectroscopic methods of examination and quantification)

The practical work in the laboratories are conducted (with the exception of exercise #1) on a small research project where the various techniques and equipment are demonstrated and the practical use is trained.


The course addresses to a public (master and PhD students) that is interested in an introduction to experimental research in petrology, but does not require basic knowledge in experimental methods. However, basic knowledge in petrology and physical chemistry (thermodynamics) is required to follow the course.

651-4114-00L Illustrations in Natural History (University of Zürich) W 1 credit 1V University lecturers

This course will provide the opportunity to develop drawing skills which can be applied for scientific studies and publications. We emphasis the reproduction of natural objects with and without interpretations. Technical and 3D-drawings as well as descriptive geometry are not dealt with in this course.

651-4273-00L Numerical Modelling in Fortran W 3 credits 2V P. Tackley

This course gives an introduction to programming in FORTRAN, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

651-4273-01L Numerical Modelling in Fortran (Project) W 1 credit 1U P. Tackley

This course gives an introduction to programming in FORTRAN, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

1 credit

2 credits 2S

2 credits

3 credits

1 credit

1 credit

1 credit

1 credit
G. Haug

7A

1S

Understanding of a broad scope of current problems and state-of-the-art practice in seismology.

Seminar in Seismology

E-, J. W. Kirchner,

University lecturers

Informal seminars with both internal and external speakers on current topics in Structural Geology, Tectonics and Rock Physics. The seminar series with both invited speakers from both inside and outside the ETH.

Research Seminar Structural Geology and Tectonics

E- Dr 0 credits 1S

N. Mancktełow, J. P. Burg, M. Frehner

A seminar series with both invited speakers from both inside and outside the ETH. The seminars present current problems and research activities in the seismological community.

Objective

Understanding of a broad scope of current problems and state-of-the-art practice in seismology.

Content

A seminar series with both invited speakers from both inside and outside the ETH. The seminars present current problems and research activities in the seismological community.

101-0317-00L

Tunnelling I

W 3 credits 2G

G. Anagnostou, E. Pimentel

Basic aspects of design and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement), Numerical analysis methods.

Objective

Numerical analysis methods in tunnelling. Conventional excavation methods (full face, top heading and bench, side drift method, ...)

Content

- Injections
- Jet grouting
- Ground freezing
- Drainage
- Forepoling
- Face reinforcement

Lecture notes

Autographblätter

<table>
<thead>
<tr>
<th>Literature</th>
<th>Empfehlungen</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-1091-00L</td>
<td>Colloquium Department Earth Sciences</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Invited speakers from the entire range of Earth Sciences. Selected themes in sedimentology, tectonics, palaeontology, geophysics, mineralogy, paleoclimate and engineering geology on a regional and global scale.</td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>According to variable program.</td>
</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Literature</strong></td>
<td>No</td>
</tr>
<tr>
<td>651-2613-00L</td>
<td>Humangeography III (Geographies of Difference)</td>
</tr>
</tbody>
</table>
| **Abstract** | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO232

Prerequisite: Human Geography II (UZH Module Code: GEO122) |

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html |
| **Content** | - Sie vertiefen ihre theoretischen, empirischen und methodischen Fähigkeiten in folgenden Themenbereichen: 
  - Gesellschaft und Raum
  - Gesellschaft und Entwicklung
  - Gesellschaft und natürliche Umwelt/Ressourcen
  - Offenheit und Geschlossenheit in Wirtschaft und Gesellschaft
  - Chancen und Herausforderungen einer globalisierten Weltwirtschaft
  - Sie sind in der Lage, Verknüpfungen zwischen grundlegenden sozial- und wirtschaftswissenschaftlichen Theorien und deren Konkretisierung in der Geographie herzustellen.
  - Sie können die erwähnten Themen mit ausgewähltem Faktenwissen verkürzen und diskutieren
  - Sie schulen Ihre analytischen und theoretischen Fähigkeiten und können diese in Diskussionen einbringen
  - Sie können die Relevanz von weiterführenden wissenschaftlichen Texten diskutieren und mit einem Ausgangstext verknüpfen
  - Sie sind in der Lage, eine Diskussion über wissenschaftliche Themen zu strukturieren und - mit einfachen Moderationstechniken - zu moderieren |
| **Prerequisites / notice** | Besuch von GEO122. |
| 651-2601-00L | Human Geography I: One Earth - Many Worlds |
| **Abstract** | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO972

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html |
| **Objective** | Imparting of research questions and basic principles in Human Geography |
| **Content** | (1) Society and space (2) Society and development (structure and dynamic of population, urbanisation, disparities (3) Society and natural environment (natural resources; food security, sustainability) |
| **Lecture notes** | PowerPoint-slides (German) |
| 651-4088-03L | Physical Geography III (Geomorphology and Glaciology) |
| **Abstract** | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO231

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html |
| **Objective** | Das Modul bietet eine kurze Einführung in einige Komponenten und Prozesse des hydrologischen Kreislaufs. Dabei werden einzelne Wasserspeicher (Schnee-, Boden- und Grundwassern) und Flüsse zwischen den Speichern (Verdunstung, Niederschlag und Abfluss) betrachtet. Übungen ergänzen die Vorlesung. |
| 651-4088-01L | Physical Geography I (Fundamentals and Spheres) |
| **Abstract** | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO111

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html |
Introduction to Cartography and Visualization (University of Zürich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH, course moved to spring semester.

UZH Module Code: GEO975

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Geophysical Fluid Dynamics and Numerical Modelling Seminar

Abstract

Heat and Mass Transfers in Magmatology

Abstract

Heat and mass transfers in the crust control many aspects of the differentiation of our planet, including (1) type of volcanic eruptions we should expect at the surface of our planet, (2) the volcanic/plutonic ratio in the crust, and (3) how volcanic degassing occurs, with important consequences on the climate response following volcanic eruptions.

Objective

The goal of this class is to learn about the modern methods and ideas on heat and mass transfers in magmatology through recently published papers and computer softwares. The class will allow students to explore some of the most challenging concepts in this field, and become familiar with state-of-the-art techniques to model these processes.

Content

The class will focus mostly on reading recent literature on topics of interests, and will contain some computer exercises to allow students to work by themselves on some well-defined problems.

Geological Colloquium

Abstract

Invited speakers from the entire range of Earth Sciences.

Objective

Selected themes in sedimentology, tectonics, paläontology, geophysics, mineralogy, paleoclimate and engineering geology on a regional and global scale.

Content

Lecture notes

No

Literature

No

Prerequisites / notice

The presentations are held in German. Membership of the Geological Society in Zurich is not required.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-ERDW.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

MSc Project Proposal

Number Title Type ECTS Hours Lecturers

651-4060-00L MSc Project Proposal O 10 credits 21A T. Schneider, Lecturers

The MSc Project Proposal is only offered in autumn semester, a registration in spring semester is subject to special approval by the study director.

Abstract

The main purpose of the Master Project Proposal is to help students organize ideas, material and objectives for their Master Thesis, and to begin development of communication skills.

Objective

The main objectives of the Master Project Proposal are to demonstrate the following abilities:

- to formulate a scientific question
- to present scientific approach to solve the problem
- to interpret, discuss and communicate scientific results in written form
- to gain experience in writing a scientific proposal

Prerequisites / notice

All students writing the MSc Project Proposal must attend an introductory lecture on "Conduct as a Scientist" by Prof. Tapio Schneider held in autumn semester.

Master Thesis

Number Title Type ECTS Hours Lecturers

651-4062-00L Master's Thesis O 30 credits 64D Lecturers

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme;
c. have successful completed the MSc Project Proposal

Additional registration required in the Learning Agreement Tool on http://la.erdw.ethz.ch required.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

Number Title Type ECTS Hours Lecturers
Mathematics as a tool to solve engineering problems. Mathematical formulation of technical and scientific problems.

P. Tackley

see list in scriptum.

Fundamentals of Geophysics

S. Wiemer

Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth.

T. Gerya

Dynamic Earth I and II

M. Akveld, O. Bachmann

Mathematical tools for the engineer

Lithosphere

J. P. Burg

E. Kissling

S. Bernasconi

Understanding basic geological and geophysical processes

Exercises and short excursions in small groups (10-15 students) will be lead by student assistants. Specific topics in earth sciences will be discussed using examples and case studies. Hand samples of the major rock types will be described and interpreted. Short excursions in the region of Zurich will permit direct experience with earth science processes (e.g. earth surface processes) and recognition of earth science problems and solutions relevant for modern society (e.g. building materials, water resources). Working in small groups will allow for discussion and examination of actual earth science themes.

Textbooks in English:


Textbooks in German:

- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag
- L. Papula: Mathematik für Ingenieure und Naturwissenschaftler, Vieweg Verlag
- M. Akveld, R. Sperb: Analysis II, vdf
- M. Akveld, R. Sperb: Analysis I, vdf
- J. Stewart: Multivariable Calculus, Thomson Brooks/Cole

Chapters:
1. 2. 3. 4. 5. 6 (without: 6-5, 6-6, 6-8), 7. 8 (without 8-9), 9. 10 (without 10-10), 11 (without 11-7), 13 (without 13-13, 13-14), 14 (without 14-6), 15 (without 15-3, 15-5)

406-0052-AAL

Physics I

Enrolment only for MSc students who need this course as additional admission requirement.

Objectives:
Introduction to the concepts and tools in physics: mechanics of point-like and rigid bodies, elasticity theory, elements of hydrostatics and hydrodynamics, periodic motion and mechanical waves.

Content:
Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter. The student should acquire an overview over the basic concepts in mechanics.

Book:
### Tectonics 651-3521-AAL

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth.

**Objective**
Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

**Content**

**Lecture notes**
Detailed scriptum in digital form and additional learning modules (www.lead.ethz.ch) available on intranet.

**Literature**
see list in scriptum.

**Prerequisites / notice**
PPT-files of each lecture may be played back for rehearsal on www.lead.ethz.ch.

### Chemistry I and II 529-2001-AAL

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry

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

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

**Lecture notes**
Nivaldo J. Tro
Chemistry - A molecular Approach (Pearson), Chapter 1-18

**Literature**
Housecroft and Constable, CHEMISTRY
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY

### Stochastics (Probability and Statistics) 406-0603-AAL

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

**Objective**
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

**Content**
From "Statistics for research" (online)
- Ch 1: The Role of Statistics
- Ch 2: Populations, Samples, and Probability Distributions
- Ch 3: Binomial Distributions
- Ch 6: Sampling Distribution of Averages
- Ch 7: Normal Distributions
- Ch 8: Student's t Distribution
- Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
- Ch 1: Basics
- Ch 2: The R Environment
- Ch 3: Probability and distributions
- Ch 4: Descriptive statistics and tables
- Ch 5: One- and two-sample tests
- Ch 6: Regression and correlation

**Literature**
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  - From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435
  - From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m1757b/
### Earth Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
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</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Science Education Master

E. Hafen
3 credits

Specialist aspects of biology are covered from the angle of imparting these to pupils, their historical development, and their significance for

ECTS

S. Hofer
Hours

L. Schalk
ECTS

E. Stern

In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.

Thematische Schwerpunkte:

Current Research on MINT Learning

Support and Diagnosis of Knowledge Acquisition Processes (EW3) ■

Enrolment only possible with matriculation in Teaching Diploma, except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW3.

Prerequisites: successful participation in 851-0240-00L "Human Learning (EW1)".

851-0240-16L

This coloquium focusses on the presentation of research projects conducted by the professorships participating in the competence center EducETH which concern learning in the STEM subjects. STEM stands for science, technology, engineering, and mathematics. Doctoral students and postdoctoral researchers will present their current projects and theoretical and methodological aspects will be discussed in a roundtable discussion. Additionally, you will learn about how to present your research in an effective way to a wider audience. You will have the opportunity to practice communicating your research findings and to receive feedback from your peers and faculty.

Objective

Prerequisites / notice

For a smooth semester planning, we request your personal attendance at the first lecture event.

Abstract

Literature

Folien werden zur Verfügung gestellt.

851-0240-00L

Human Learning (EW1)

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

Abstract

Objective

This course is only apt for students who intend to enroll in the programs "Teaching Diploma" or "Teaching Certificate". It is about learning in childhood and adolescence.

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

Content

Thematical Schwerpunkte:

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

Lernformen:


Prerequisites / notice

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

### Content

Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module comprises the parts:

1. Lecture (Tues. 08.00-09.45 hrs)
2. Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3. Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4. Semester thesis in a research group (3.5 weeks)

### Lecture notes

Literature

Unterlagen für den Unterricht werden online mit Hilfe der e-learning Platform OLAT abgegeben.

Lectures

Literatur und Literaturhinweise werden mit der e-learning Platform OLAT abgegeben.

### Prerequisites / notice

This Course lasts for two semesters. It can be started in autumn or in spring. Booking is only required once.

Performance Assessment:

Performance is assessed during the course of the entire modul, with a final test. Active participation in the colloquia and group seminars is required. The thesis report and an oral presentation have to be completed.

The Specialized Biology Course with an Educational Focus (12 CP) can be acknowledged, in agreement with the advisor of the respective elective major, as one of the two obligatory research projects (each 15 CP). In such a case, additional 3 CP must be obtained in another course.

In case of overbooking of the course, students enrolled in the Teaching Diploma in Biology will have priority for registration.

The course is organized jointly with the University of Zurich (Fachbereich Biologie) and is held at the Life Science Zurich Learning Center of the ETH Zurich and the University of Zurich.

### Subject Didactics

#### Number 551-0963-02L

**Specialized Biology Course with an Educational Focus II: Teaching Diploma**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>13A</th>
<th>E. Hafen, J. Egli, M. Zwicky</th>
</tr>
</thead>
</table>

**Abstract**

Specialized aspects of biology are dealt with under the viewpoint of their presentation, their historical development, their significance for the field, the individual and society.

**Objective**

The goal is to promote the ability to understand biological concepts, principles and their interrelationships and to communicate specialist knowledge to various groups of recipients in an understandable manner.

**Content**

- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered on the basis of the subject structure and learner requirements.
- The students can use different forms of examination for monitoring performance.
- They can select appropriate media for their work (e.g. school books) and use these. They can employ appropriate experiments.
- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.
- They can perform, off the cuff, 12 school experiments (which they have tested themselves), from the different subject areas, and conduct these correctly in technical terms. They can incorporate these experiments in their tuition in a didactically meaningful manner. Comments:
  - By contrast to the Subject Specialisation 1 and 2 course units, these are "basic tests" and do not involve the implementation of current research topics. The students' compilations are available in a data archive.

**Lecture notes**

None.

**Literature**

Specific references will be made available for the individual projects.

**Prerequisites / notice**

The program of this course represents one half (6 CP) of that of the Specialized Biology Course with an Educational Focus (551-0963-00, 12 CP).

### Subject Didactics

#### Number 551-0913-00L

**Professional Exercises in Biology**

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>2U</th>
<th>P. Faller</th>
</tr>
</thead>
</table>

**Abstract**

Students conduct a series of "classical" biological school experiments and therefore gain practice and experience in this area.

**Objective**

Implementation of Subject Didactics I and II with the focus on conducting biological experiments in schools. This includes finding, testing and further developing suitable protocols for different subject areas of school biology. Working out how to didactically embed the experiments in lessons.

Students can perform, off the cuff, 12 school experiments (which they have tested themselves), from the different subject areas, and conduct these correctly in technical terms. They can incorporate these experiments in their tuition in a didactically meaningful manner.

**Content**

2. Die Studierenden führen alle ausgearbeiteten Experimente selber durch.
4) Semester thesis in a research group (7 weeks)

**Lecture notes**

Hand out of course material.

**Prerequisites / notice**

Der Teil biologische Experimente findet im Rahmen von 7 Halbtagen statt.

### Number 551-0971-00L

**Subject Didactics Biology I**

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>P. Faller</th>
</tr>
</thead>
</table>

**Abstract**

- Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics.
- Application of teaching methods and techniques from educational science in biology classes.
- Planning and preparation of lessons.

**Objective**

- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the school-leaving examination (Matura), the framework curriculum and the conditions and objectives specified by their school.
- They are in a position to select learning objectives and formulate these on the basis of the target level model. They can plan and prepare lessons and can also develop appropriate learning assignments.
- Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements.
- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.
- They can select appropriate media for their work (e.g. school books) and use these. They can employ appropriate experiments.
- The students can use different forms of examination for monitoring performance.
- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.

---

Maturitätsreglement, Lehrpläne und Standards. Lernziele in der Content of the four modules:

3G

R. Alberto

Hours

ECTS

Ausgewählte Artikel aus der Primärliteratur werden vorgestellt, kommentiert und zur Lektüre empfohlen.

This course imparts fundamental didactic concepts that are relevant to teaching science in a Higher Education context.

Students are able to characterize and to discuss the model of outcomes based education.

Folien und ausgewählte Literatur werden zur Verfügung gestellt.

Students are able to transfer the basic concepts of this model (ILO, TLA, assessment, constructive alignment) to science education.

keines


(bitte das Buch in der Auflage von 2011 vor dem ersten Treffen erwerben!)

▶ Chemical Direction

▶ Specialised Courses

▶ Introductory Courses

Selection of courses will be agreed with the course coordinator.

▶ Spec. Courses in Respective Subject with Educational Focus

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
529-0962-00L | Fundamental Aspects of Chemistry with an Educational Focus B | W | 4 credits | 2V | A. Togni, R. Alberto

*Mentored Work with an Educational Focus Chemistry B for Teaching Diploma.*

*Students enrolled at UZH must register for this course and the corresponding exam at ETH.*

Abstract

Selected topics in general chemistry:

1) The language of chemistry
2) Chirality and stereochemistry
3) Oxidation of water
4) Chemistry of the atmosphere

Objective

In this course, participants acquire extended and more in-depth knowledge of selected chemistry topics. The selection is based on a large extent on the partial aspects of chemistry that are typically taught at high school. By gaining a broader understanding, teachers are put in a position where they can comprehend the topics that are to be taught in a wider and, to some extent, unconventional context and critically process these in respect of their teachability and learnability. At the same time, interrelationships between the classical sub-disciplines of chemistry are highlighted, along with the unique features of chemistry as one of the central natural sciences.

Content

Content of the four modules:

1) The language of chemistry: Concepts, formulas, aesthetics, and philosophical aspects
2) Chirality and stereochemistry: Selected aspects, origin of biomolecular chirality, inorganic chemistry
3) Cosmochemistry
4) Chemistry of the atmosphere

Lecture notes

Foliendruck und ausgewählte Literatur werden zur Verfügung gestellt.

Prerequisites / notice

Prerequisites / notice

Literature

Ausgewählte Artikel aus der Primärliteratur werden vorgestellt, kommentiert und zur Lektüre empfohlen.

▶ Subject Didactics

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
529-0950-00L | Subject Didactics Chemistry I Simultaneous enrolment in Introductory Internship Chemistry - course 529-0966-00L - is compulsory. | W | 4 credits | 3G | A. Baertsch

Abstract

Implementing findings from research into teaching and learning for chemistry lessons and coverage of subject-specific teaching and learning specialties.

Objective

Among other things, students are put in a position where they can

- divide up the subject matter into contents that can be learned by heart or accessed intellectually, and communicate these contents.
- break down technically complex contents to the right level for a class and still present these in a stringent, error-free manner in their simplified form.
- establish which subject matter can be presented with which teaching techniques and methods that have been recognised as efficient in teaching terms, and adapt these tools to the learning content in question.
- plan school experiments, incorporate them in lessons, perform them in accordance with all the rules of the art, and also evaluate them in a beneficial manner.
- assess pupils' prior knowledge, clarify it in greater detail and take it into account for planning lessons.
- design a sequential curriculum suitable for the levels in question and put it into practice.
- reliably identify stumbling blocks in the contents and get round these.

Content

Schwerpunkte im ersten Studiensemester bilden die folgenden Themen:

- Auswahl gymnasiumsrelevanter Lerninhalte
- Modellbegriff in den Naturwissenschaften, insbesondere der Chemie
- Sprache und Fachsprache im Chemieunterricht
- Wechselspiel zwischen Beobachtungen in der realen Welt und Deutungsversuchen auf der Modell-Ebene
- Interdisziplinarität mit Biologie, Mathematik und Physik
- Leistungserhebung und -beurteilung im Theorie- und Laborunterricht
- Atommodelle und chemische Bindung
- Mathematische Beschreibung chemischer Systeme (z.B. Stöchiometrie und Gleichgewichtssysteme)

Lecture notes

Prerequisites / notice
Der Chemieunterricht am Gymnasium soll einerseits dem zukünftigen Nichtnaturwissenschaftler ein grundlegendes Rüstzeug an chemischen Kenntnissen und Fähigkeiten für den Alltag an die Hand geben, andererseits aber auch auf ein naturwissenschaftlich orientiertes Hochschulstudium vorbereiten können. Diese beiden Anforderungen sind im Unterricht gleichermaßen zu berücksichtigen.

Da viele Lerninhalte zudem zwingend sequentiell und einander benützend strukturiert sind, ist dem logischen und aus Schülerperspektive nachvollziehbaren Aufbau des Unterrichts besonderes Augenmerk zu schenken. Dies bedingt eine besonders feine Abstimmung von fachlichen Inhalten unterschiedlichen Niveaus und der für ihre Vermittlung eingesetzten didaktischen Methoden und Techniken auf die kognitive Leistungsfähigkeit der Lernenden.

Anhand der Diskussion ausgearbeiteter und bewährter Beispiele, aber auch durch selbständiges Probearbeiten und mit Hilfe selbst zu erstellender kleiner Unterrichtsbausteine soll die zukünftige Lehrkraft befähigt werden, einen den spezifischen Rahmenbedingungen angepassten eigenen Unterricht zu konzipieren und durchzuführen, der diesem hohen Qualitätsanspruch genügen kann.

### 402-0091-00L

**Teaching science in Higher Education**

W 2 credits

1V F. Schiltz

**Objective**

This course imparts fundamental didactic concepts that are relevant to teaching science in a Higher Education context.

Students are able to characterize and to discuss the model of outcomes based education.

Students are able to transfer the basic concepts of this model (ILO, TLA, assessment, constructive alignment) to science education.

**Lecture notes**

keines

**Literature**


(please buy the book in the fall of 2011 before the first meeting!)

### Physical Direction

#### Specialised Courses

##### Introductory Courses

#### Spec. Courses in Respective Subject with Educational Focus

**Number**

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0737-00L</td>
<td>Energy and Environment in the 21st Century (Part I)</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
</tr>
</tbody>
</table>

**Abstract**

The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

**Objective**

Scientists and espially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21. century.

**Content**

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

physics basics of nuclear fission and fusion energy

controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparision with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: “exotic” ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

new clean renewable energy sources and their physical limits (wind, solar, geothermal etc).

Energy perspectives for the next 100 years and some final remarks

**Lecture notes**

http://ihp-lx2.ethz.ch/energy21/

**Literature**


Environmental Physics: Boeker and Egbert New York Wiley 1999

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize:

It never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

402-0944-00L  Science in School (Current Topics for the Classroom)  W  2 credits  2G  C. Wagner, A. Vaterlaus

Content

Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.

402-0910-00L  Physics Didactics I: Special Didactics of Physics Teaching  W  4 credits  3G  M. Mohr

Limited number of participants.

Further information is available from the lecturer via email: mamohr@ethz.ch

Simultaneous enrolment in Introductory Internship Physics - course 402-0920-00L - is compulsory for Teaching Diploma Physic

Objective

Die Studierenden verfügen über fachdidaktisches Grundwissen für den Physikunterricht an einer Mittelschule. Sie können eigene Lektionen unter Berücksichtigung der vielfältigen Rahmenbedingungen planen, durchführen und evaluieren. Sie reflektieren ihren Unterricht und sind bestrebt, ihn didaktisch und pädagogisch weiter zu entwickeln.

Die Studierenden kennen die Einsatzmöglichkeiten, Chancen und Schwierigkeiten verschiedener Unterrichtsarten und Hilfsmittel. Sie können die Eignung von Unterrichtsformen im Hinblick auf eine Lernsituation beurteilen. Sie bemühen sich in ihrem Unterricht, geeignete Methoden und Medien anhand oder einpassen an die Klasse und das Thema einzusetzen.


Content

Thematische Schwerpunkte


Fachspezifisches: Sachstrukturen der gängigen Unterrichtsthemen, Alltagsbezüge, Fehlvorstellungen, Demonstrations- und Schülerexperimente, Arbeitsmittel zu physikalischen Themen des Grundlagen- und Schwerpunktunterrichts

Einsatz verschiedener Unterrichtsmaterialien: Experimente, Computer, Taschenrechner, Video, Simulation Unterrichtsformen: Lernaufgabe, Werkstatt, Puzzle, Projekt, Gruppenarbeit, Praktikum Lernformen

Interaktive Lehr-Lernveranstaltung mit Vorträgen und Demonstrationen des Dozenten, studentischer Einzel- und Kleingruppenarbeit, kurzen Präsentationen der Studierenden, Vertiefung der Inhalte durch Bearbeitung von Aufträgen ausserhalb der Kontaktstunden

Lecture notes

Folien und weitere Unterlagen werden zur Verfügung gestellt

Literature

wird während der Veranstaltung mitgeteilt

Prerequisites / notice

Die Veranstaltung ist zusammen mit dem Einführungspraktikum zu belegen

402-0091-00L  Teaching science in Higher Education  W  2 credits  1V  G. Schiltz

Abstract

This course imparts fundamental didactic concepts that are relevant to teaching science in a Higher Education context.

Objective

Students are able to characterize and to discuss the model of outcomes based education.

Students are able to transfer the basic concepts of this model (ILO, TLA, assessment, constructive alignment) to science education.

Lecture notes

keines

Literature


(Anmerkung: Bitte das Buch in der Auflage von 2011 vor dem ersten Treffen erwerben!)
### General Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0587-00L</td>
<td>CIS Colloquium</td>
<td>Z Dr</td>
<td>2 credits</td>
<td>2K</td>
<td>L.E. Cederman, M. Steenbergen</td>
</tr>
<tr>
<td>851-0551-00L</td>
<td>Colloquium for Master and Ph.D. Students</td>
<td>Z Dr</td>
<td>2 credits</td>
<td>1K</td>
<td>D. Gugeri</td>
</tr>
<tr>
<td>851-0158-02L</td>
<td>Collective Constructivism. Philosophy and Sociology</td>
<td>Z</td>
<td>3 credits</td>
<td>2S</td>
<td>H. von Sass</td>
</tr>
<tr>
<td>851-0158-03L</td>
<td>Scientific Research Between Anomaly and Orthodoxy</td>
<td>Z</td>
<td>2 credits</td>
<td>1S</td>
<td>H. W. Atmanspacher</td>
</tr>
<tr>
<td>851-0158-04L</td>
<td>Economization and Commercialization in Science</td>
<td>Z</td>
<td>1 credit</td>
<td>2S</td>
<td>G. Folkers, H. von Sass</td>
</tr>
<tr>
<td>851-0158-05L</td>
<td>Relations between Descriptive Levels in Science: Reduction or Emergence?</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>H. W. Atmanspacher</td>
</tr>
<tr>
<td>851-0300-99L</td>
<td>Science Fiction in Theory and Practice (University of Zurich)</td>
<td>W</td>
<td>6 credits</td>
<td>2S</td>
<td>P. Theisohn</td>
</tr>
</tbody>
</table>

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**CIS Colloquium**

This seminar is open for staff members based at the Center for Comparative and International Studies, CIS.

**Abstract**

In this seminar staff members of the Center for Comparative and International Studies (CIS) and external guests present and discuss their research.

**Objective**

In this seminar staff members of the Center for Comparative and International Studies (CIS) and external guests present and discuss their research.

**Content**

Presentation and discussion of current research.

**Lecture notes**

Distributed electronically.

**Literature**

Distributed electronically.

---

**Colloquium for Master and Ph.D. Students**

Colloquium for master and doctoral students preparing a thesis in the history of technology.

**Abstract**

Goals: to identify, discuss, and resolve methodological problems that emerge while elaborating a master or doctoral thesis.

**Prerequisites / notice**


---

**Collective Constructivism. Philosophy and Sociology**

In his seminal monograph "The Structure of Scientific Revolutions" Thomas Kuhn referred to an author who anticipated some of his groundbreaking ideas. That was, however, an understatement: Ludwik Fleck (1896-1961), a doctor, microbiologist and bacteriologist, forgotten for a long time, defended a collective constructivism, sociologically informed.

**Objective**

The seminar aims at introducing into the work of Ludwik Fleck with special regard to the philosophy of science. It gives also the opportunity to deal with basic problems of the subject of the philosophy of science in general, but also of the sociology and parts of the history of science - and all this by well accessible and well written texts.

---

**Scientific Research Between Anomaly and Orthodoxy**

Scientific research takes place in the field of tension between established (coherent) knowledge and not understood, not integrated fragments: between orthodoxy and anomaly. We will work out a topography of anomalies based on their potential of being connected with the accepted body of knowledge and discuss examples from particular scientific disciplines.

**Objective**

This seminar attempts to generate awareness that scientific work is most interesting at the frontier between established knowledge and unknown territory – between the understood and the non- or not-yet understood. We will collect examples of historical anomalies in science and develop a systematic classification for them. Then we will look at anomalies in contemporary science and try to assess them according to the topography developed.

---

**Economization and Commercialization in Science**

The entrepreneurial university is a reality. "In this sense, the entrepreneurial university must maximize profit, countable, in the capture of research funds, recruiting distinguished scientist, the number of applicants for a study place and ultimately, as controversial as they may be, the placement in rankings." (Richard Münch 2003)

**Objective**

Participants are able to detect, analyze and understand "economic divers" within science and universities.

---

**Relations between Descriptive Levels in Science: Reduction or Emergence?**

Reduction or emergence are relations between different levels of descriptions of a system, its states and properties, or their dynamical behavior. Their general characteristics and differences will be introduced and discussed for selected examples in particular scientific disciplines. The representation of such interlevel relations in the pertinent literature will be critically assessed.

**Objective**

1. Students will be introduced to different approaches to conceive interlevel relations in individual sciences.
2. They will be guided to identify and compare their basic structure, in order to locate commonalities and differences.
3. Specific examples will be used to show how the basic structure is realized.
4. The discussion of (some of) these examples in the philosophy of science will be studied and critically assessed.
5. Essays (up to 6 pages) by the students will be required so that they learn how to combine in-depth disciplinary insights with an interdisciplinary outlook concerning structural determinants of scientific research in general.

---

**Science Fiction in Theory and Practice (University of Zurich)**

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

**Abstract**

Following Bourdieu's argument, Science Fiction is not to be understood as "Para-Literature", but as a type of literature with an own poetological discourse. In this course, we would like to approach this specific discourse and get familiar with its programmatic outlines as well as with its crucial debates.

**Objective**

Following Bourdieu's argument, Science Fiction is not to be understood as "Para-Literature", but as a type of literature with an own poetological discourse. In this course, we would like to approach this specific discourse and get familiar with its programmatic outlines as well as with its crucial debates. We are going to read authors such as Darko Suvin, Stanislaw Lem, Dietmar Dath and Reinhard Jirgl. Next to obviously connected topics (posthuman writing, virality and fiction, story-telling in unearthly spaces) we will also put a focus on the genesis and definition of certain genres, such as Cyberpunk, "Hard SF", the "Space Opera" a.s.o.

**Literature**

### Military Studies

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0037-01L</td>
<td>Military Psychology and Pedagogy I (without Exercises)</td>
<td>Z</td>
<td>3</td>
<td>2V</td>
<td>H. Annen</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>Examine the fundamentals of the two sciences and establish links with military life. Discuss various schools of thought in psychology and focus on content and process theories of motivation. Explore characteristics of pedagogical thinking and discuss the values of military education with reference to the young adult serving in the armed forces.</td>
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</tbody>
</table>
| **Objective**    | - Becoming acquainted with basic psychological views of human behaviour and experience  
                   - Knowing content- and process theories of motivation and being able to transfer them to the military context  
                   - Knowing the possibilities and limitations of military education and deriving consequences |      |      |           |               |
| **Content**      | Overall, the objective is to become acquainted with the basics of both scientific areas and to make references to military practice. Military psychology is a branch of applied psychology; consequently selected aspects of psychological principles will be covered. Military pedagogy hasn't yet established itself firmly as an independent scientific discipline, it nevertheless can draw on a deep-seated tradition in Switzerland. Thus, the great importance that has been attached to the discussion of education in Swiss society and academia will be taken into account. |      |      |           |               |
| **Subjects:**    | - History of military psychology  
                   - Psychological images of humanity (psychoanalysis, behaviourism, behavioural biology, humanistic psychology, cognitivism)  
                   - Motivational theories  
                   - Defence-, service-, operational- and combat motivation  
                   - Swiss military pedagogy  
                   - Education as defining feature of pedagogic thinking and acting |      |      |           |               |
                   - Stadelmann, J.: Führung unter Belastung, Huber, Frauenfeld 1998 (provided as pdf) |      |      |           |               |

The lecture is supported by a virtual learning environment containing relevant documents (presentations and texts) and information to further literature.

<table>
<thead>
<tr>
<th>853-0063-00L</th>
<th>Military History I (with Exercises)</th>
<th>Z</th>
<th>4</th>
<th>2V+1U</th>
<th>M. Olsansky</th>
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<tr>
<td><strong>Abstract</strong></td>
<td>The lecture outlines the development of the armed forces (assets regarding manpower, technology and armament), the concepts of warfare and the actual warfare in the 19th and 20th century.</td>
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</table>
| **Objective**    | - Distinguish between military history as a subject and historiography as a way of describing events; 
                   - Analyse the modern developments regarding armed forces and warfare in the context of socio-economic changes; 
                   - Based on the approach regarding revolution in military affairs, describe the evolution of the armed forces and of warfare; 
                   - Exemplify the issues regarding the evolution of the combat (First and Second World War, Vietnam War and Algerian War). |      |      |          |               |
| **Content**      | The lecture first examines the bases of the science of (military) history. It focuses on how military history developed from war history, on specific similarities and differences between military history and general historiography, the different ways of dealing with history in Switzerland, Germany, France and in the Anglo-Saxon cultural area (different approaches) as well as on institutions which deal with military history such as universities, military academies, national and international commissions and associations etc. |      |      |          |               |

The lecture is structured along the lines of the concept of "Military Revolution" and starts with the formation of modern, European armed forces after the Oranian Army reform in the 17th century. Based on the "Military Revolution" approach, the lecture examines the structural changes regarding the armed forces and the development of warfare from the 18th to the 20th century. Special emphasis will be put on how the battlefield was revolutionized due to the Napoleonic wars, the industrialization in the 19th century, the First World War, the mechanization and totalization during the Second World War and the period of the Cold War.

<table>
<thead>
<tr>
<th>853-0082-00L</th>
<th>Strategic Studies I</th>
<th>Z</th>
<th>3</th>
<th>2V</th>
<th>M. Mantovani</th>
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</thead>
<tbody>
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<tr>
<td><strong>Abstract</strong></td>
<td>The lecture series, spread over two terms, deals with the leading concepts of (military) strategy and theories of war from antiquity to the present. It focuses in particular on the backgrounds of these concepts, their implementation as well as their significance for subsequent conceptual thinking.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The participants know the classical conceptions of strategy and war theory from antiquity to the present against their specific background. They recognize aspects, which are useful for the understanding of modern/current conflicts. They are capable of analyzing critically original texts and modern scholarly works in the field of strategic studies.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The lecture series introduces the basic concepts of strategy and war theory and wants to present the variety of asymmetric warfare throughout history. It critically highlights in particular Sun Tzu, Machiavelli, Jomini, Clausewitz, Moltke, Mahan, Corbett, Douhet, Fuller, Liddell Hart, Swetchn, Tuchatschesky, Mao and Che Guevara, etc. (see program). If appropriate, a specific Swiss view is being applied.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>A textbook with primary sources and a list of further reading are available with the lecturer or electronically on the MILAK website (Lehre und Forschung/Dozentur/Vorlesungsunterlagen). Slides are being distributed.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>see &quot;Skript&quot;</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>853-0102-00L</th>
<th>Military Business Administration II - Case Examples</th>
<th>Z</th>
<th>3</th>
<th>2V</th>
<th>M. Keupp</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td><strong>Abstract</strong></td>
<td>The elective course Military Business Administration II builds on the mandatory course Military Business Administration I and adds to it. It deals with in-depth case studies from international security and economic policy with a special emphasis on the economic and practical relevance of these issues for the Swiss Armed Forces.</td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students who are intrinsically interested in business-related issues will be provided with a big picture that transcends the micro view of business administration. Students learn how to integrate security and resource-related issues into a global economic analysis and how to derive relevant consequences, particularly economic ones, for Switzerland.</td>
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</tbody>
</table>
The program of the course is organized into 14 units of 90 minutes each. The units combine the elements of lecture (where analytical concepts are taught) and application (where these concepts as applied). Additionally, guest lecturers will hold talks on selected issues.

- Swiss economic autarchy - madness or option?
- Global resource positions and world trade: Implications for the Swiss Armed Forces I
- Global resource positions and world trade: Implications for the Swiss Armed Forces II
- Economic causes of military instability
- Aggressive emerging economies: Economic growth and rearmament
- The process of an arms deal
- Costs and financing of a military conflict
- Economic analysis of cyberwar
- Economic analysis of the present GSOA initiative: Compulsory military service vs. voluntary militia
- Global arms production and international arms trade
- The privatisation of military security
- Standardisation and interoperability: Does NATO membership increase Swiss military efficiency
- Written exam

Lecture notes
As this course has been completely redesigned and is being offered for the first time in the fall semester of 2013, a script is not yet available. However, the lecturer will distribute all necessary course material in time and directly to the students, either in the classroom or by uploading files to a public server.

Literature
The Lecturer will distribute all necessary literature directly to the students by disseminating pdf files or citing links to online references.

Prerequisites / notice
Exam "Military Business Administration I" passed successfully or profound basic knowledge of business administration and economics. The course is open to external participants.

853-0064-00L Military Sociology I Z 3 credits 2V T. Szvircsev Tresch

Abstract
Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.

Objective
Recognize and explain current changes (social change) in modern society (individualisation, pluralisation); describe demographic changes in Switzerland; explain the structures of societies; define issues and fields of research in modern military sociology and explain the foundations of organisational sociology; explain the military in terms of organisational sociology and identify specific traits of the military as an organisation.

Content
Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.

Literature
A reader with a set of texts will be handed out.

Specialized Continuing Education
Special internal ETH courses offered by LET and the Teaching Specialists.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>999-9999-99L</td>
<td>EduApp Course</td>
<td>E-</td>
<td>0 credits</td>
<td>1V+1U</td>
<td>G. Schiltz</td>
</tr>
</tbody>
</table>

This course unit is not a genuine ETH course unit. It is used by LET and the Teaching Specialists for EduApp demonstration purposes.

Humanities, Social and Political Sciences (General Courses) - Key for Type

<table>
<thead>
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<th>O</th>
<th>W+</th>
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<tr>
<td>Compulsory</td>
<td>Eligible for credits and recommended</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E- Recommended, not eligible for credits</td>
<td>Z Courses outside the curriculum</td>
<td>Dr Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>G</th>
<th>U</th>
<th>S</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>lecture</td>
<td>lecture with exercise</td>
<td>exercise</td>
<td>seminar</td>
<td>colloquium</td>
</tr>
<tr>
<td>P practical/laboratory course</td>
<td>A independent project</td>
<td>D diploma thesis</td>
<td>R revision course / private study</td>
<td></td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
GESS Compulsory Electives Course

Only the topics listed in this paragraph can be chosen as GESS compulsory elective course

Further below you will find the "Type B courses Reflections about subject specific methods and content" as well as the language courses.

Type A: Enhancement of Reflection Competence

Suitable for all students

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0549-12L</td>
<td>Sharing, The History of an Attractive Technology</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>D. Gugerli</td>
</tr>
</tbody>
</table>

Abstract: The seminar deals with hot topics of the history of technology since the 1960s. Sharing of computertime, software and data will be discussed as a crucial offer and problem of late modernity.

Objective: The course wants to develop the students ability to critically read and asses historic texts.

Lecture notes: A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0101-46L</td>
<td>Introduction in the History of Economic Thought</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td></td>
</tr>
</tbody>
</table>

Abstract: The course offers a historical introduction to modern economic thought. It looks at texts of 'classical economics' as well as 'neo-classical', 20th century texts. In addition, the course addresses some modern contributions in the history of economics - in particular extra-European economic history - and their potential for the enrichment of mainstream economic thought.

Objective: The course is conceptualized as an introduction to the history of economic thought. It acquaints students with the basic tenets of the 'classical economics' through historical accounts of the work of 'worldly philosophers' as well as primary reading of authors such as Adam Smith, David Ricardo and Karl Marx. Further, the course introduces students to 'neoclassical economics' of the 20th century, again looking at authors of particular significance in the furtherance of economic debates such as John Maynard Keynes, Milton Friedman and Friedrich Hayek. The course, however, takes also a closer look at authors whose work is usually situated beyond conventional economic thought, such as Karl Polanyi. Additionally, the course devotes also time to some extra-European economic thought - drain theory, world system and dependency theory, etc. - and its implications/applications in the history of the 20th century. Finally, a particular attention will be paid to some important contributions in the extra-European history of economics and to specific notions such as 'commodity chains', 'divergences' and 'modernization'. Combining these various items, the course aims not simply at introducing students to the 'evolution of economic thought', but more broadly to ongoing academic debates, political and ideological tensions as well as to critical interventions. The ambition of the course is to inspire through a historical approach and to enrich the 'understanding' of economic theory with a questioning of its underlying structures and tenets and, ultimately, to advance critical thinking among students of modern economics.

<table>
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<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0549-00L</td>
<td>WebClass Introductory Course History of Technology</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>D. Gugerli</td>
</tr>
</tbody>
</table>

Abstract: WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Objective: Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.


Literature: https://www.tg.ethz.ch/de/programme/


Weitere Informationen unter https://www.tg.ethz.ch/de/programme/

851-0535-10L | Yemen: A Failed State?                                                | W    | 2 credits | 2V    | E. Manea |

Abstract: Is Yemen a failed state? The Yemen Republic is the result of the unification in 1990 of two former states: The Yemen Arab Republic (NorthYemen) and the People's Democratic Republic of Yemen (South Yemen). The country's history and its former units have been marred with civil wars, poverty and epidemic corruption.

Objective: 1. Examine the concept of failed state within the International relations literature.
2. Take a closer look at Yemen(s) political history(ies), its/their political and social structures, and power dynamics.
3. Introduce the concept of the 'cunning state' and its exploitation of the discourse of failed state

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 553 of 1432
This seminar looks at the concept of failed states and how useful it can be in describing the situation in a country like Yemen. It will also take a closer look at Yemen(s) political history(ies) and its/their political and social structures. Students are expected to write a paper and make a presentation.

853-0725-00L History Part One: Europe W 3 credits 2V M. Mühlenheim

Abstract
Using concrete regional examples, this lecture offers a survey and analysis of the crucial historical transformations that engendered "modernity" in Europe from the late 18th to the mid 20th centuries.

Objective
At the end of this lecture course, students can: (a) highlight the most important changes in the "long nineteenth century" in Europe (b) explain their long-term effects; and (c) relate these changes to global developments.

Content
The thematic foci include: the economic and social consequences of the industrial revolution, the genesis of political ideologies and social movements, shifts in gender roles, colonialism and imperialism, as well as the emergence of consumerism and a "leisure society."

Lecture notes
Power Point Slides and handouts will be made available at https://ilias-app2.let.ethz.ch/goto.php?target=crs_85655&client_id=ilias_lda in the course of the semester.

Literature
Mandatory and further reading will be made available at https://ilias-app2.let.ethz.ch/goto.php?target=crs_85655&client_id=ilias_lda.

Prerequisites / notice

051-0363-00L History of Urban Design I W 2 credits 2G V. Magnago Lampugnani

Abstract
The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the historical plannings and methods of European cities. Each specific urban development will be presented within a broader context.

Objective
This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.

Content
In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.

01. Introduction to the discipline and method: The history of urban design as a historical project

02. Athens and Rome in the ancient world: Myth, selfportrayal and speculation

03. From the spirit of equality to the colonial module: Greek and Roman City foundings

04. From the urban ideal to new cities in the two cities and the Renaissance

05. Baroque strategies: The new organisation of Rome under Sixtus V, the production of Versailles under Louis XIV and the invention of St. Petersburg

06. The city between Absolutism and Enlightenment: baroque defence-designs, the European colonization of the American continent and the reconstruction of Lisbon

07. Ideology and speculation after the Glorious Revolution: landscepagardens and urban figurations in England from 1650-1850

08. Between modernization, Grandeur and repression: Embellishment in Paris from 1750-1830

09. The construction of the bourgeois city: Georges-Eugène Haussmann transforms Paris into the capital of the 19th century

10. Architectural insertion and plan for the expansion of the city: From the Berlin of Karl Friedrich Schinkel to James Hobrecht

11. Neobasepower, bougese self-confidence and Marxian Idealism: The Viennese Ringstrasse and Ildenfons Cerdas Ensanche for Barcelona

Lecture notes
The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30,-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

Literature
Further recommended literature to consult is listet within the script.

Prerequisites / notice
History of Urban Design from antiquity to the 19th century

051-0331-00L History of Art and Architecture I W 4 credits 4G L. Schmitt, U. Schulte-Umberg

Abstract
The lecture conveys historical knowledge about architecture and art as well as methodical knowledge as a preparation for the independent handling of historical sources and scientific literature. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

Objective
Acquirement of basic knowledge of the history of art and architecture, resp. of methodical basic knowledge of historical working.

Content
The history of art and architecture is part of our reality: it confronts us in the historically shaped environment of the city and plays an essential role in the creation of architecture. The historical lectures are therefore part of the fundamental courses of the undergraduate programme in architecture. On the basis of cultural and art-historical research the courses impart knowledge about architecture and art from ancient times to the present. At the same time they sharpen the perception for the conditions and capabilities of building activity in history. Moreover, they convey methodical knowledge and technical language skills and are meant as a preparation for the independent handling of historical sources and scientific literature.

The first one-year course aims at these goals in the form of exemplary epoch representations which through light upon the historical continuities. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

Lecture notes
3 Skripte sind auf der Professur, HilC 70.5-8, erhältlich:
- Architektur der Klassischen Antike, Fr. 15.-
- Renaissance und Barock, Fr. 15.-
- Aufklärung bis Moderne, Fr. 15.-

Prerequisites / notice
Zu beziehen am Dienstag und Donnerstag

The course can not be taken by Master students of the D-ARCH, who have already completed it within the Bachelor programme.

051-0311-00L History of Art and Architecture III W 3 credits 2V L. Stalder

Autumn Semester 2015
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0300-95L</td>
<td>Writing Between Cultures. German-Jewish Literature and Cultural Knowledge 1822-1933</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>A. Kilcher</td>
</tr>
<tr>
<td>851-0300-92L</td>
<td>Institutionalisation of Modernity: &quot;Der Sturm&quot;, a German Art &amp; Literary Magazine, Edited by Herwarth</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>S. S. Leuenberger</td>
</tr>
<tr>
<td>851-0306-05L</td>
<td>Literature and Technology - Simulations, Prototypes, Machines</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td></td>
</tr>
<tr>
<td>851-0309-13L</td>
<td>&quot;Materialmärchen&quot;: Thomas Mann's Zauberberg from the Point of View of the History of Knowledge</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>J. Reidy</td>
</tr>
<tr>
<td>851-0325-01L</td>
<td>Censorship, Caricature and System Criticism: Knowledge of Diversity in the Work of Oskar Panizza</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td></td>
</tr>
</tbody>
</table>

Combinatorics is a procedure shared by various disciplines. In mathematics it concerns the calculation of quanta and probabilities, in philosophy the creation of encyclopedic knowledge, in mysticism the achievement of ecstatic experience, in literature, finally, experimental writing. This course investigates these different forms of combinatorics.

Objective

- comparative understanding of combinatorics as a transcultural and transdisciplinary procedure to generate knowledge
- cultural and epistemology of combinatorics since the medieval ages
- combinatorics in theology, mysticism and occultism
- combinatorics in literature and literary theory

Abstract

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Content

Oskar Panizza, a central figure of the Williamian Epoch, has left an indelible mark on literature and trend analysis. His works have become influential in the study of interdisciplinary approaches to literature and its social functions in historical contexts.

On the Contemporary Prominence of Religions

Facing the recent return of religion in the public sphere, we discuss concepts of the relation of religion and modernity: the classical theories of secularization and the actual discussion of the post-secular, anthropology of religion, political theology, psychoanalytic and postcolonial theories of religion.

Objective

- Training problem oriented circumvention of literature and its social functions in historical contexts
- critical reading of theoretical and literary texts that deal with the tension between scientificity and history.

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Objective

- Training problem oriented circumvention of literature and its social functions in historical contexts
- critical reading of theoretical and literary texts that deal with the tension between scientificity and history.

Content

The seminar is dedicated to the texts of scandal author Oskar Panizza. Especially the dogmas and beliefs of the Christian churches caused a stir in the 19th century. The seminar is dedicated to the texts of scandal author Oskar Panizza. Especially the dogmas and beliefs of the Christian churches caused a stir in the 19th century.

Return of Religions, 'Religious turn', Postsecularity:

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On the Contemporary Prominence of Religions

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**Introduction to English Literature: Science and Fiction**

*W. M. Olender*  
*F. Kretzen*

Introduction to English Literature: Science and Fiction

A. Brand-Kilcher

**Part I**

**Abstract**

"Plot is to the novelist what experiment is to the scientist." (Lionel Trilling) We will read Emile Zola's essay "The Experimental Novel" and other texts to look on the one hand at the scientific aspect to fiction and fiction writing and on the other hand at the narrative and fictional aspects to science.

**Objective**

Compare and find out about differences and similarities between natural sciences and fiction/fiction writing. Maybe become aware that "to conclude that what happens in the laboratory is what happens in the universe requires a leap of the imagination." (Trilling)

**Content**

We will look at a number of essays and texts on that subject. We will also read Zadie Smith's highly entertaining novel "White Teeth" which has a very elaborate not to say artificial plot. One line of the story is about the geneticist Marcus Chaffen and the "Future Mouse" he designed.

**Literature**

Recommended Reading: Zadie Smith: White Teeth; Emile Zola: The Experimental Novel

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**Writing: Precision of Language as a Field of Research**

*C. Hölscher*

Writing: Precision of Language as a Field of Research

F. Kretzen

**Objective**

The goal is to explore some of the diverse representations of modern Rome that portray historical, political, subjective, and/or fantastical elements that have interacted over time to produce the palimpsest that is the city of Rome. Films by Fellini, Rossellini, Pasolini, and Bertolucci as well as some films directed by non-Italians will be viewed and explored; fiction by D’Annunzio, Moravia, Pasolini, and Malerba will be read in conjunction with specific films.

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**Writing for Literature**

*U. J. Wenzel*

Writing for Literature

F. Kretzen

**Objective**

Writing to write texts, that can present topics from the sciences to an interested public (in newspapers, non-specialist journals but also in papers for non-specialists in an academic context); to gain insights into the cultural, historical and philosophical contexts of science and the public.

**Content**

Practical exercises in writing articles for the feature pages of newspapers will be combined with the theoretical work on topics relevant for the historical, sociological and philosophical aspects of writing for others.

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**Behavioral Studies Colloquium**

*C. Hölscher*  
*A. Brand-Kilcher*  
*C. Hülscer, H.D. Daniel, A. Diekmann, D. Helbing*

Behavioral Studies Colloquium

**Abstract**

This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their research ideas in relation to behavioral science. The colloquium also features invited research talks.

**Objective**

Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages.
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in so far as they have some relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education, Sociology, Modelling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper.

Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the course. Students interested in giving a talk should contact the course organizers (Schinazi, Hoelscher) before the first session of the semester. Priority will be given to advanced / doctoral students for oral presentations. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0609-05L</td>
<td>The Economics of Climate Change</td>
<td>3 credits</td>
<td>Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended</td>
</tr>
<tr>
<td>851-0626-01L</td>
<td>International Aid and Development</td>
<td>2 credits</td>
<td>Prerequisites: Basic knowledge of economics</td>
</tr>
<tr>
<td>151-0757-00L</td>
<td>Environmental Management</td>
<td>2 credits</td>
<td>Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended</td>
</tr>
<tr>
<td>860-0006-00L</td>
<td>Statistical Data Analysis</td>
<td>3 credits</td>
<td>Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended</td>
</tr>
<tr>
<td>363-1027-00L</td>
<td>Introduction to Health Economics and Policy</td>
<td>3 credits</td>
<td>Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended</td>
</tr>
</tbody>
</table>
Lecture notes, exercises and reference material can be downloaded from Moodle.

Corporation Sustainability

The course introduces basic principles, problems and approaches of microeconomics. It includes the following main topics:

- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

Objective

- Understand the limits and potential of corporate sustainability for sustainable development
- Be able to recognize and realize opportunities for corporate sustainability in a business environment
- Develop critical thinking skills for corporate sustainability

Content

- Overview of the grand sustainability challenges of Water, Energy, Mobility, and Food
- Critical thinking skills for corporate sustainability
- In-depth case study of concrete corporate sustainability challenge in the group project phase, such as: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze radical innovations for sustainability? How to invest money in a sustainable way?

Lecture notes

- Presentation slides will be distributed prior to lectures.

Literature

- Literature recommendations will be distributed during the lecture

Principles of Microeconomics

The course introduces basic principles, problems and approaches of microeconomics. It includes the following main topics:

Objective

- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

Content

- Overview of the grand sustainability challenges of Water, Energy, Mobility, and Food
- Critical thinking skills for corporate sustainability
- In-depth case study of concrete corporate sustainability challenge in the group project phase, such as: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze radical innovations for sustainability? How to invest money in a sustainable way?

Lecture notes

- Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature

- For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book: N. Gregory Mankiw and Mark P. Taylor (2014), "Microeconomics", 3rd edition, South-Western Cengage Learning. The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

Financial Market Risks

I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.

Objective

- Development of the concepts and tools to understand these risks and master them.
- Working knowledge of the main concepts and tools in finance (Portfolio theory, asset pricing, options, real options, bonds, interest rates, inflation, exchange rates)
- Strong emphasis on challenging assumptions and developing a systemic understanding of financial markets and their many dimensional risks
Content

1- The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.

2- Risks in financial markets
- What is risk?
- Measuring risks of financial assets
- Introduction to three different concepts of probability
- History of financial markets, diversification, market risks

3- Introduction to financial risks and its management.
- Relationship between risk and return
- Portfolio theory: the concept of diversification and optimal allocation
- How to price assets: the Capital Asset Pricing Model
- How to price assets: the Arbitrage Pricing Theory, the factor models and beyond

4- Financial markets: role and efficiency
- What is an efficient market?
- Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
- Deviations from efficiency, puzzles and anomalies in the financial markets
- Financial bubbles, crashes, systemic instabilities

5- An introduction to Options and derivatives
- Calls, Puts and Shares and other derivatives
- Financial alchemy with options (options are building blocs of any possible cash flow)
- Determination of option value; concept of risk hedging

6- Valuation and using options
- A first simple option valuation model
- The binomial method for valuing options
- The Black-Scholes model and formula
- Practical examples and implementation
- Realized prices deviate from these theories: volatility smile and real option trading
- How to imperfectly hedge with real markets?

7- Real options
- The value of follow-on investment opportunities
- The timing option
- The abandonment option
- Flexible production
- Conceptual aspects and extensions

8- Government bonds and their valuation
- Relationship between bonds and interest rates
- Real and nominal rates of interest
- Term structure and Yields to maturity
- Explaining the term structure
- Different models of the term structure

9- Managing international risks
- The foreign exchange market
- Relationships between exchange rates and interest rates, inflation, and other economic variables
- Hedging currency risks
- Currency speculation
- Exchange risk and international investment decisions

Lecture notes
Lecture slides will be available on the site of the lecture

Literature
Corporate finance
Brealey / Myers / Allen
Eight edition

+ additional paper reading provided during the lectures

Prerequisites / notice
none

751-1501-01L Development Economics II W 2 credits 2V A. C. Crole-Rees, U. Egger

Abstract
The objectives of this course are to: understand the role of agriculture in the development process; learn about the relevant actors, the small-scale farmers, and how to integrate them into economic development and to be able to derive sound policy measures.

Objective
Development economics II is a follow-up of "Development economics I".

Content
The main topic is the role of agriculture and in the development process. The main features of this sector will be presented. In many developing countries that are at the beginning of economic development the largest share of the population is often involved in agriculture. In agriculture the production factor land is more important than in other sectors. Agriculture together with fisheries is the only sector that produces food. Food can either be produced locally or imported.

Farmers, even small-scale farmers, are integrated in the monetary world. Trade is very important for growth, food security and environment conservation.

The following topics will be tackled: role of agriculture in economic development, definition of sustainability, role of the various stakeholders in the agricultural sector.

Lecture notes
PPT and selected articles. A monograph is also distributed.

Literature

Prerequisites / notice
Prerequisite: Attendance of introductory micro- and macroeconomics classes. Development economics I & II are one unit.
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

Objective
The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structure of technology, and an introduction to entrepreneurship.

The slides of the lectures are made available and updated continuously through the SMI website:

Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

Reading assignments: please consult the SMI website:

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Discovering Management offers an integrated learning system, which combines in an innovative format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

The lectures for Discovering Management are designed to broaden the participant's understanding of the principles of entrepreneurial management, emphasizing the interdependence of various specialties in the development and management of a firm. For this reason, the lectures are structured on the basis of a coherent business model and will be presented by the respective area specialists at D-MTEC. The lectures broaden the view and the understanding of technology by interlinking it with society. Corporate sustainability, for example, introduces economic, ecological and social issues that are relevant to all engineering disciplines. Practical examples stimulate the students to assess these issues and be aware of their responsibilities as engineers. Technology and innovation management, to mention a second example, focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students' ability to see the business and social consequences of their 'technical' decisions.

Critical skills will be trained by the case study exercises, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant's appreciation for the complex tasks companies deal with.

Discovering Management attempts to overcome the limitations of traditional teaching curricula of management in technical universities, which often merely focus on transferring specific skills to students, e.g. planning or forecasting. In response to the new challenges for entrepreneurial decision-making, students will be offered the opportunity to actively engage in an advanced business game simulation; a business game that establishes a link between business management theory and business management in practice. The simulation presents a realistic model of a company and provides participants with the opportunity to quickly gain the lasting effects of practical experience in a risk-free environment. All this provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyze the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.
Politics of Environmental Problem Solving in Developing Countries

Abstract
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

Objective
After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries’ realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Content
Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

Lecture notes
Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle).

Literature

Environmental Policy of Switzerland I

Abstract
This course presents the basics of policy analysis and the specific characteristics of Swiss environmental policy. Political instruments, actors and processes are addressed both theoretically as well as by means of current Swiss environmental policy examples.

Objective
Beyond acquiring basic knowledge about policy analysis, this course teaches students how to analytically address current and concrete questions of environmental policy. Through exercises the students learn about political science concepts and frameworks as well as real-life political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the environmental (policy) workforce or a future research career.

Content
The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on social and political institutions. In the interplay between the environment, society and economy, the environmental policy field encompasses the sum of public measures that have the goal to eliminate, reduce or avoid environmental degradation. The course provides insight into the development of Swiss environmental policy and systematically presents the basics of environmental policy actors, instruments, programs and processes as well as their change over time. A key aspect is the distinction between politics and political science and specifically environmental policy.

Lecture notes
Instead of lecture notes different texts on policy analysis and Swiss environmental policy are made available to the students.

Literature
Students are able to
- describe fundamental micro- and macroeconomic issues and theories.
- apply suitable economic arguments to a given theme.
- evaluate economic measures.

Content
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomic policies

Lecture notes
available online on electronic platform

Literature


Prerequisites / notice
electronic plattform

701-0985-00L Social Intercourse with Current Environmental Risks W 1 credit 1V B. Nowack, C. M. Som-Koller

Abstract
The lecture treats the social intercouse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

Objective
- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)

Content
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- prospects for future developments

Lecture notes
Copies of slides and selected documents will be distributed

Prerequisites / notice
The lecture is held biweekly (for 2 hours). The dates are 21.9., 28.9 (attention, out of schedule) ; 19.10; 2.11, 16.11, 30.11, 14.12

363-1050-00L Conference of Disarmament: Simulation of Negotiations W 3 credits 2S M. Ambühl

Abstract
The Global Studies Institute (University of Geneva) is organizing a simulation seminar on nuclear disarmament in collaboration with the Chair of Negotiation and Conflict Management (ETH), experts from the United Nations Institute for Disarmament Research and the Geneva Center for Security Policy.

Objective
Students will have the possibility to participate in simulated diplomatic negotiations and to analyse and assess the negotiation logic behind the situations. They should gain insight in the basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general.

Content
The simulation project is intended for Master's or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Geneva Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations), of observer of the minutes or of observers and analysts.

Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the "Capitals" to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

Dates/Time/Location (GE = University of Geneva)
22 Sept. | ETH HG D 22 | 10:15-12:00 | Introduction
29 Sept. | GE Uni Mail Salle 1170 | 10:15-12:00 | Introduction to Negotiation Techniques (Dr. Vitalija Butenko and Dr. Sibylle Zürcher, ETH)
6 Oct. | ETH HG D 16.2 | 10:15-12:00 | Distribution of the roles, composition of the negotiation tables, preparation of mandates for the HA (humanitarian approach)
13 Oct. | ETH HG D 22 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)
20 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | No session; Students deepen and summarize their mandates on one page (A4)
27 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates II (FMCT)
10 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the mandates II (HA)
17 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Preparation Meeting
26 & 27 Nov. | GE Salle 407 et 408 | 10:00-18:00 | Simulation at Uni Dufour
1 Dec. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the results

Note:
The participation in the simulation on 26. and 27. November in Geneva is necessary.
The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation in Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(Technical note for registration: At this stage all registered students are on the waiting list)
1. Analysis and discussion of different interpretations of the virtue "wisdom".

- **Objective**: Key problems of research projects will be discussed. Participants will learn to know arguments and ideas dealing with systematic problems in philosophy.


- **Objective**: Participants will make acquaintance with foundling texts of the natural rights property concept (John Locke). They will see the connection between inalienable self-ownership, prohibition of slavery, derivative commercial rights and modern personal rights. They will learn about the problems of self-ownership today concerning property in one's body and intellectual property. Critical alternatives to the property paradigm will be discussed.

3. Discussion of the questions what constitutes wisdom today and whether wisdom is a goal of the good life.

- **Objective**: Participants will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts and orient themselves in current bioethical, juridical and political discussions.

4. Examination of the relevance of wisdom in practical and theoretical contexts.

- **Objective**: Participants will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts and orient themselves in current bioethical, juridical and political discussions.

5. Introduction into Philosophy of Technology

- **Abstract**: The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protokoll is to be written.

6. Self-Ownership - Philosophical and Juridical Perspectives

- **Abstract**: Rights in Objects are founded by an inalienable Self-Ownership. These idea ist central for personal rights. We speak of my body, my genes, my name, my portrait, my ideas oder ways of expression.

7. Introduction into Philosophy of Technology

- **Abstract**: Rights in Objects are founded by an inalienable Self-Ownership. These idea ist central for personal rights. We speak of my body, my genes, my name, my portrait, my ideas oder ways of expression.

8. Wisdom, Certainty, Insecurity

- **Abstract**: Wisdom is widely - maybe even universally, at all times and everywhere - regarded as one of the highest virtues. But what constitutes wisdom? Is wisdom compatible with uncertainty? Does a wise person have to be certain or can she be uncertain? These and related questions will be discussed in the seminar to gain an understanding of what wisdom, certainty and uncertainty are.

9. Man and Machine

- **Abstract**: The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.

10. Central Questions in Bioethics

- **Abstract**: Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like "Protect the dignity of the living being"; or "Respect a person's self-determination"? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account.

11. Research Colloquium for Ph.D.-Students and Members of Staff

- **Objective**: Ph.D. students and members of staff report on their research.
### Literature


### 851-0144-01L Introduction to the Philosophy of Physics

- **W 3 credits 2S N. Sieroka**
- **Particularly suitable for students of D-MAVT, D-MATL**

**Abstract**

This is an introductory course in different areas and positions in the philosophy of physics. It falls into different parts, including one on the concepts of space and time and one on the reality of structures in physics.

**Objective**

Students should be able to name and critically evaluate different topics and approaches in the philosophy of physics.

### 851-0144-07L The Infinite in Philosophy and in the Exact Sciences: Logic, Mathematics, Physics

- **W 3 credits 2S G. Sommaruga**
- **Number of participants limited to 40. Particularly suitable for students of D-MATH, D-PHYS**

**Abstract**

On the one hand, the topic of the infinite will be dealt with historically by discussing philosophical texts, by e.g., Kant, Bolzano and Cantor. On the other hand, the topic will be treated from a (non-historical) scientific point of view: the point of view of logic, mathematics, and physics.

**Objective**

To get acquainted with different types of infinitness; to study what is intriguing or problematic about the infinite; to inquire whether these different types of infinitness have (important) features in common.

### 851-0144-15L The Beginning of Scientific Enquiry - History and Impact of Presocratic Natural Philosophy

- **W 3 credits 2V N. Sieroka**

**Abstract**

Several questions and notions introduced by presocratic natural philosophy are still considered important (albeit in historically altered forms, of course). This applies, e.g., to the notion of the infinite, the process character of nature, and atomism. The present lecture discusses both, the origin of these notions and their persistent relevance for later approaches in philosophy.

**Objective**

By the end of the lecture the students are able to describe and classify different approaches and notions in presocratic philosophy. Moreover, they are able to critically compare and evaluate them in relation to later approaches in natural philosophy.

### 851-0145-04L History and Philosophy of Pharmacy

- **W 3 credits 2S S. Baier**
- **Particularly suitable for students from D-CHAB.**

**Abstract**

The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts.

**Objective**

The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts.

### 851-0148-02L Manifolds and Individuation in Mathematics and Philosophy

- **W 3 credits 2S T. Böhm**
- **Number of participants limited to 40. Particularly suitable for students of D-BIOL, D-MATH, D-PHYS**

**Abstract**

Manifolds and individuation are concepts which allow to reconsider notorious problems such as the relationship between general and particular, substance and modi, physical processes and persons. They may incorporate heterogeneous elements as needed to overcome traditional categories and classifications, and also describe processes leading to the existence of things.

**Objective**

The students should become familiar with some conceptual possibilities to recognise and deal with structures across the usual division of subjects. The problem areas are discussed on the basis of texts of various mathematicians and philosophers, with a wide range of applications such as psychology and life sciences.

### 851-0180-00L Research Ethics

- **W 2 credits 2G G. Achermann**
- **Particularly suitable for students of D-BIOL, D-CHAB, D-HEST**

**Abstract**

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

**Objective**

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts.
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry
---------------------------------------
Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------
Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.
**Objective**
The overarching objective of this seminar is to get an impression of the specificity of biological problems and to develop an appropriate philosophical sensibility. Accordingly, philosophical traditions in biology will be discussed, just as the application of the history of concepts in the context of biology. The seminar will consist of contributions of biologists as well as philosophers of biology. Besides the basic concepts in biology such as gene, species, evolution, or diversity, we will be also reflecting on the relationship between technology, experimenting, and biological objects. Depending on the interests of the seminar participants, the examples to be discussed may be chosen from systems biology, molecular or synthetic biology, ecology or else.

**Abstract**
The course explores various strands in philosophy of science in a critical way, focusing on the notion of rationality in science, especially with regards to environmental research. It addresses the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

**Content**
1. Core differences between classical Greek and modern conceptions of science.
2. Classic positions in the philosophy of science in the 20th century: logical empiricism and critical rationalism (Popper); the analysis of scientific concepts and explanations.
3. Objections to logical empiricism and critical rationalism, and further developments: What is the difference between the natural sciences, the social sciences and the arts and humanities? What is progress in science (Kuhn, Fleck, Feyerabend)? Is scientific knowledge relativistic? What is the role of experiments and computer simulations?
4. Issues raised by the use of science in society: The relation between basic and applied research; inter- and transdisciplinarity; ethics and accountability of science.

**Lecture notes**
A reader will be available for students.

**Literature**
A list of introductory literature and handbooks will be distributed to the students.

**Prerequisites / notice**
The optional exercises accompany the lecture and offer the opportunity for an in-depth discussion of selected texts from the reader.

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**Philosophy of Science: Exercises**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0577-00L</td>
<td>Principles of Political Science</td>
<td>W Dr</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>S. Mohrenberg, Q. Nguyen</td>
</tr>
</tbody>
</table>

**Abstract**
This course covers the basic questions, concepts, theories, methods, and empirical findings of political science.

**Objective**
This course covers the basic questions, concepts, theories, methods, and empirical findings of political science.
This course is based on the following textbook:

Z. Bakaki

Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design International Environmental Politics

P. Aerni

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

T. Bernauer

Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of the environment will be discussed from a short-term and a long-term perspective.

851-0594-00L

International Environmental Politics

W 4 credits

2V T. Bernauer

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

Objective

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

Content

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

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

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

Lecture notes

Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your Nethz username and password to access the material.

851-0595-01L

International Organizations

W 3 credits

2S Z. Bakaki

Abstract

This course offers a comprehensive examination of the role of international organizations (IOs) in world politics. Besides teaching the basic theories and methods that are necessary for studying IOs, this course considers the application of those theories and methods to a range of special institutions.

Objective

The first part of this course offers an introduction and will seek to explain how, if at all, IOs obtain some measure of authority in international affairs, i.e., why states delegate certain tasks to IOs instead of dealing unilaterally or multilaterally outside of an institutional context. The second part of the course focuses on the impact and effectiveness of international institutions. We assess whether and how IOs influence state compliance with agreements, and whether IOs socialize states to behave in certain ways. The third and final part of the course examines a special set of IOs: international alliances and international regimes, i.e., explicit principles, norms, rules, and decision-making procedures that define expected behavior in a specific problem field.

851-0589-00L

Technology and Innovation for Development

W Dr 3 credits

2V P. Aerni

Abstract

Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

Objective

- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

Content

Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies.

The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g., environmental regulations, anti-trust law) or facilitate (e.g., intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.
A reading list will be handed out at the beginning of the semester.

3 credits

Compulsory Reading: Conflict Research I: Causes of War in Historical

Students will receive a handout of slides accompanying the lectures.

4 credits

D. Möckli

Students should acquire a sound understanding of Swiss foreign policy and the relevant academic and political debates associated with it. World Politics Since 1945: The History of International

By the end of the semester, participants of the lecture should have a solid knowledge on the history and theoretical foundations of International Relations since the end of the Second World War. This course analyzes the foundations and central challenges of Swiss foreign policy. After reviewing the history of foreign and neutrality policy conceptions since the early 20th century, the determining factors of Swiss foreign policy will be discussed, and issues such as the Ukraine crisis, Swiss-EU relations, and Switzerland and the Middle East will be examined.

853-0038-00L

Swiss Foreign Policy

This course will be supported by an e-learning environment.

The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester. The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

Lecture notes

Students will receive a handout of slides accompanying the lectures.

853-0047-01L

World Politics Since 1945: The History of International Relations (Without Exercises)

This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

By the end of the semester, participants of the lecture should have a solid knowledge on the history and theoretical foundations of International Relations since the end of the Second World War.


Prerequisites / notice

The lecture is being supported by a virtual classroom. If you have any questions, please contact Lukas Meyer, lukas.meyer@sipo.gess.ethz.ch.

853-0015-00L

Conflict Research I: Causes of War in Historical Context

This course offers an introduction to research on causes of wars. War as a social phenomenon is covered from the pre-state world to today's state system after the end of the Cold War. Topics include state formation and collapse, nationalism, decolonization, democracy, and ethnic conflict.
### Objective

Developing an understanding for causes of war and their development over the last 500 years. Knowledge of fundamental concepts in research on causes of war.

### 853-0302-00L European Integration: Seminar

**W** 4 credits 

**3S** F. Schimmelfennig

#### Abstract

The seminar covers the theory, development, and core policy fields of European integration as well as structures and processes of the EU as a decision- and policy-making system.

#### Content

1. Introduction
2. Development of European integration
3. Integration theories
4. Deepening
5. Widening and differentiation
6. Attitudes and public opinion
7. The institutions of the EU
8. Legislation and adjudication in the EU
9. Democracy in the European Union
10. Internal market and monetary union
11. Foreign and security policy
12. Justice and home affairs
13. EEA, Switzerland, and Neighbourhood Policy

#### Literature


#### Prerequisites / notice

The seminar is designed to help students understand the European Union as a particular kind of political system that differs both from the nation-state and from other international organizations. It imparts basic knowledge on the development, institutions, procedures, and policies of the EU and provides an introduction to major approaches to integration theory and political science research on the EU.

### 853-0060-00L Current Issues in Security Policy

**W** 3 credits 

**2V** A. Wenger, O. Thranert

#### Abstract

This course provides an overview of the development of the international system and the central security challenges since the end of the Cold War. The focus of this course will be on security issues of the post 9/11 era: new risks, arcs of crises, security strategies and core actors will be presented during the course.

#### Objective

Participants should gain a solid understanding of current issues in international security policy as well as of the central academic debates.

#### Content

The aim of the course is to provide the participants with an overview of international security politics in a globalized world. After dealing with the major changes of the international security environment as compared to the cold war era, we will concentrate on some of the key challenges (international terrorism, proliferation of weapons of mass destruction etc.). The third part of the lecture focuses on security strategies pursued by the 'Western' world.

#### Lecture notes

Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle.

#### Literature

A reading list will be distributed at the beginning of the spring semester.

#### Prerequisites / notice

An online learning platform serves as a supplement to the lecture course.

### 853-0033-00L Leadership I

**W** 3 credits 

**2V** F. Kernic

#### Abstract

The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

#### Objective

The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

#### Prerequisites / notice

The 1-hour written exam will take place during the last lecture in the semester.

### 860-0001-00L Public Institutions and Policy-Making Processes

**W** 6 credits 

**3G** T. Bernauer, S. Bechtold, F. Schimmelfennig

#### Abstract

This course provides an overview of the development of the international system and the central security challenges since the end of the Cold War. The focus of this course will be on security issues of the post 9/11 era: new risks, arcs of crises, security strategies and core actors will be presented during the course.

#### Objective

Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels.

#### Content

Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g. interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.

#### Lecture notes

Reading materials will be distributed to the students before the semester starts.

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Data: 06.12.2018 13:04 Autumn Semester 2015 Page 570 of 1432
### Psychology, Pedagogics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
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<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs “Teaching Diploma” or “Teaching Certificate”. It is about learning in childhood and adolescence.</td>
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<td></td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<td></td>
<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<td>Themenatische Schwerpunkte: Lernen als Verhaltensänderung und als Informationsverarbeitung; Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<td>Prerequisites / notice: This lecture is only apt for students who intend to enrol in the programs “Lehrdplom” or “Didaktisches Zertifikat”. It is about learning in childhood and adolescence.</td>
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<tr>
<td>851-0252-01L</td>
<td>Human-Computer Interaction: Cognition and Usability (EW1)</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>C. Hölscher, I. Banicic, S. Ognjanovic</td>
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<td>Number of participants limited to 20.</td>
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<td>This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.</td>
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<td>This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).</td>
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<tr>
<td>851-0252-03L</td>
<td>Cognition in Architecture - Designing Orientation and Navigation for Building Users</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>V. Schinazi, B. Emo Nax, C. Hölscher</td>
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<td></td>
<td>Particularly suitable for students of D-ARCH</td>
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<td>How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.</td>
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<td>Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they memorize the environment and how they find their way from A to B. Students will also learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking and behavior simulation for design. Students will reflect on the roles of designers and other stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture / planning, engineering, computer science and behavioral science as well as anybody interested in the relation between design and cognition. Architecture students can obtain course credit in &quot;Vertiefungsfach&quot; or &quot;Wahlfach&quot;</td>
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<td>This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their research ideas in relation to behavioral science. The colloquium also features invited research talks.</td>
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<td>Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages.</td>
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Reflections on Design Processes

The aim of the lecture is to impart a well-founded scientific understanding of social influence processes in individuals, groups, and organizations, and social settings.

Cognitive Science views human cognition as information processing and provides an interdisciplinary integration of approaches from cognitive psychology, informatics (e.g., artificial intelligence), neuroscience and anthropology among others. The lectures provide an overview of basic mechanisms of human information processing and various application domains. A focus will be on matters of knowledge acquisition, representation and usage in humans and machines. Models of human perception, reasoning, memory and learning are presented and students will learn about experimental methods of investigating and understanding human cognitive processes and representation structures.

Support and Diagnosis of Knowledge Acquisition

This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in so far as they have some relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education, Sociology, Modelling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper.

Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the course. Students interested in giving a talk should contact the course organizers (Schinazi, Hoelscher) before the first session of the semester. Priority will be given to advanced / doctoral students for oral presentations. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.

Support and Diagnosis of Knowledge Acquisition

851-0238-01L

Support and Diagnosis of Knowledge Acquisition Processes (EW3) 3 credits
Enrolment only possible with matriculation in Teaching Diploma, except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW3.

Prerequisites: successful participation in 851-0240-00L "Human Learning (EW1)"

Abstract
In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.

Objective
The main goals are:
(1) You have a deep understanding about the cognitive mechanisms of knowledge acquisition.
(2) You have a basic understanding about psychological test theory and can appropriately administer tests.
(3) You know various techniques of formative assessment and can apply these to uncover students’ misconceptions.

Prerequisites / notice
Für eine reibungslose Semesterplanung wird um persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

Social Psychology

227-0802-01L

Social Psychology 2 credits
The lecture covers the following main topics: Social perception and interpersonal judgement; attitudes; group dynamics and group performance; leadership behavior and leadership styles.

Objective
The aim of the lecture is to impart a well-founded scientific understanding of social influence processes in individuals, groups, organizations, and social settings. The participants should develop competencies in the structuring of communication, interaction, and management processes.
This course provides an introduction to psychological research and modeling, focusing on cognitive psychology and the psychological aspects of risk management and decision-making under uncertainty. Participants learn to formulate problems for psychological investigation and apply basic forms of psychological experiment. Participants learn to formulate problems for psychological investigation and apply basic forms of psychological experiment.

### Content

- an den Beispielen von Kaufverhalten oder ökologischem Verhalten zu beschreiben, wie Normen und Einstellungen Einfluss auf das Verhalten nehmen,
- Die Subjektivität und die Fehlerquellen sozialer Wahrnehmung verstehen,
- Prinzipien der Psychologie der Kommunikation zu nutzen für eine Verbesserung der Kommunikation in Studium und Beruf,
- Merkmale und Strukturen von Gruppen zu identifizieren und mit geeigneten Methoden zu analysieren,
- Die Grundlagen von Konformität und Gehorsam gegenüber Autoritäten zu erkennen,
- Gruppensphären und soziales Faulenzen, Risiko- und Konservatismus-Schub und Gruppenendenken entgegenzuwirken,
- Führungsstile zu unterscheiden lernen,
- Techniken zur Moderation von interagierenden Gruppen kennen zu lernen.

### Lecture notes

kein Skript

### Literature


### Prerequisites / notice

Es werden für D-ITET-Studierende Gruppenarbeiten (6 Kreditpunkte) in Form eines 3-tätigen computer-unterstützten Assessments ausgewählter Texten zu den Vorlesungsthemen angeboten. (Teilnehmerzahl beschränkt auf 12 Studierende). Die Teilnehmenden verfassen Berichte, die benotet werden.
This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.

The aim of this workshop is to equip students with legal skills and methods to solve or treat problems and questions of the environmental law and foster the understanding on the possibilities and limits of legal problem-solving. The students choose an inquiry with practical relevance. To this end they work out the legal basis demonstrating a legal correct solution or approach to a solution. In doing so, students will get to know legal methods and research possibilities.

At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

Den Studierenden werden Unterlagen zur juristischen Metoden- und Quellenlehre sowie zum Inhalt und Ablauf des Kurses zu Beginn der Veranstaltung kostenlos abgegeben.

At the Vorlesung "Umweltrecht: Konzepte und Rechtsgebiete" (851-0705-01) ist Voraussetzung.

The course deals with the basic legal framework for doing e-business as well as using information technology. It discusses a variety of legal concepts and rules to be taken into account in practice, be it when designing and planning new media business models, be it when solving of practical cases of their respective programme or professional interest in a guided self-study.

The objective is knowing and understanding key legal concepts relevant for doing e-business, in particularly understanding how e-business is regulated by law nationally and internationally, how contracts are concluded and performed electronically, which rules have to be obeyed in particular in the Internet with regard to third party and own content and client data, the concept of liability applied in e-business and the role of the law in the practical implementation and operation of e-business applications.

This course is particularly suitable for students of D-ARCH, D-Baug, D-USYS.

The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.

The course deals with the basic legal framework for doing e-business as well as using information technology. It discusses a variety of legal concepts and rules to be taken into account in practice, be it when designing and planning new media business models, be it when implementing online projects and undertaking information technology initiatives.

The objective is knowing and understanding key legal concepts relevant for doing e-business, in particularly understanding how e-business is regulated by law nationally and internationally, how contracts are concluded and performed electronically, which rules have to be obeyed in particular in the Internet with regard to third party and own content and client data, the concept of liability applied in e-business and the role of the law in the practical implementation and operation of e-business applications.

This course is particularly suitable for students of D-INFK, D-ITET.
Die Students shall obtain the following competence:

The Lecture and Workshop Series in Law & Finance aims at allowing participants to discuss current financial regulation and corporate governance issues with leading academics. Participants discuss current Law & Finance issues with guest scholars from Europe and the U.S. in addition, participants write a comment on one of the discussed papers.

Prerequisites / notice
Die Semesterendprüfung ist in Form eines schriftlichen Kurztests (normalerweise MC) in voraussichtlich der letzten Doppelstunde geplant. Der Test wird möglicherweise elektronisch durchgeführt.


Ferner bietet Ursula Widmer eine Vorlesung zum Thema Informationssicherheit an, welche die rechtlichen Aspekte der Sicherheit von ICT-Infrastrukturen und Netzen und der transportierten und verarbeiteten Informationen.

851-0735-04L Workshop and Lecture Series in Law and Finance W 2 credits 2S G. Hertig, S. Bechtold
Abstract The Workshop and Lectures Series in Law & Finance is a joint seminar of ETH Zurich, the University of Zurich and the University of St. Gallen. Each semester, several guest scholars from law, finance and related fields give a lecture and/or discuss their ongoing research. All speakers are internationally well-known experts from Europe, the U.S. and beyond.
Objective The Lecture and Workshop Series in Law & Finance aims at allowing participants to discuss current financial regulation and corporate governance issues with leading academics.
Content Participants discuss current Law & Finance issues with guest scholars from Europe and the U.S. In addition, participants write a comment on one of the discussed papers.

851-0735-09L Workshop & Lecture Series on the Law & Economics of Innovation W 2 credits 2S S. Bechtold, H. Gersbach, A. Heinemann, G. Hertig
Abstract The Workshop & Lecture Series on the Law & Economics of Innovation focuses on the intersection of business law and economics. This includes topics such as intellectual property, e-commerce, data protection, and international law.
Objective The Workshop & Lecture Series on the Law & Economics of Innovation aims at providing students with a comprehensive understanding of the legal and economic aspects of innovation.
Content The Workshop & Lecture Series on the Law & Economics of Innovation includes lectures on topics such as innovation policy, intellectual property, and technology transfer.

Literature
- Viral Acharya et al., Regulating Wall Street (Princeton University Press 2006)

Data: 06.12.2018 13:04
 Autumn Semester 2015
Page 575 of 1432
Abstract
This series is a joint project by ETH Zurich and the University of Zurich. It provides an overview of interdisciplinary research on intellectual property, innovation, antitrust and technology policy. Scholars from law, economics, management and related fields give a lecture and/or present their current research. All speakers are internationally well-known experts from Europe, the U.S. and beyond.

Objective
After the workshop and lecture series, participants should be acquainted with interdisciplinary approaches towards intellectual property, innovation, antitrust and technology policy research. They should also have an overview of current topics of international research in these areas.

Content
The workshop and lecture series will present a mix of speakers who represent the wide range of current social science research methods applied to intellectual property, innovation, antitrust policy and technology policy issues. In particular, theoretical models, empirical and experimental research as well as legal research methods will be represented.

Lecture notes
Papers discussed in the workshop and lecture series are posted in advance on the course web page.

Literature
Suzanne Scotchmer, Innovation and Incentives, 2004
Bronwyn Hall / Nathan Rosenberg (eds.), Handbook of the Economics of Innovation, 2 volumes, Amsterdam 2010
Bronwyn Hall / Dietmar Harhoff, Recent Research on the Economics of Patents, 2011
Paul Belleflamme / Martin Peitz, Industrial Organization; Markets and Strategies, Cambridge 2010
Einer Elhauge / Damien Geradin, Global Competition Law and Economics, 2007
Dennis Carlton / Jeffrey Perloff, Modern Industrial Organization, 4th edition, 2004


851-0735-11L Environmental Regulation: Law and Policy W 3 credits 1S J. van Zeben
Number of participants limited to 15.
Particularly suitable for students of D-USYS

The course is fully booked

Abstract
The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

Objective
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Content
Topics covered in lectures:

(1) Environmental Regulation
   a. Perspectives
   b. Regulatory Challenges of Environment Problems
   c. Regulatory Tools
(2) Law: International, European and national laws
   a. International law
   b. European law
   c. National law
(3) Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

851-0738-00L Intellectual Property: Introduction W 2 credits 2V M. Schweizer
Particularly suitable for students of D-ITET, D-MAVT, D-MATL

Abstract
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights).

Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.
The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

The seminar is customised to the needs of engineers. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.

The seminar contains practical exercises on the use and research of patent information. Basic knowledge on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

For students of chemistry-related degree programs, the lecture 'Protecting inventions in chemistry' will be offered, which is coordinated to the needs of students in these degree programs.

The lecture gives students of chemistry-related degree programs an overview of the options to protect inventions and the underlying investments in research and development. The lecture aims to put the participants in a position to be able to use this know-how in the workplace.

Investments in the development of new substances and active component in these sectors are traditionally secured by patents because publicly known inventions, generally chemical substances, may easily be reproduced by others.

In the last years, the know-how about intellectual property has become increasingly important for chemists and engineers. Both in the production process and in the distribution sector, chemists and engineers are increasingly concerned with questions related to patenting inventions and the use of patent information. As more than three-quarters of all publicly available technical information is reportedly available only in patents, it is more and more important for researchers and engineers to be capable of extracting relevant information from the flood of patents.

Patents are not only a measure to protect investments and inventions in chemistry-related sectors but also an important source of information about competitors and potential cooperation partners, about the development of markets and the risks of infringing others' patents. Accordingly, the know-how about patents and patent information has also become a key qualification at a company's strategic level.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.
- Special aspects of protecting inventions in chemistry-related sectors, including polymorphs and inventions in the field of nanotechnology.

The seminar contains practical exercises on the use and search of patent information in chemistry-related sectors. Basic know-how on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, biotechnology, chemical engineering, chemistry, food science, pharmaceutical sciences.
Cooperation and Fairness: Theories and Experiments

Cooperation and fairness in encounters with strangers are puzzling behaviors, since they contradict the law of natural selection. Yet daily experience as well as field and laboratory studies reveal that humans cooperate and behave fairly. This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance. The learning concept is based on the coordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning. This course covers the basics of modern scientific research and discusses different types of scientific misconduct. Case studies are introduced and the latest diagnostic methods for uncovering data manipulation presented. Problem solving is discussed.

Objectives

1. To be able to recognize and evaluate scientific misconduct and its causes against the background of the competition-oriented systems of modern scientific research.
2. To get to know methods for uncovering data manipulation and to be able to critically assess them.

Content


Prerequisites / notice


Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
851-0596-00L | Data Manipulation, Deception and Fabrication in the Sciences | W | 2 credits | 2V | A. Diekmann, J. Jerke
851-0517-05L | Cooperation and Fairness: Theories and Experiments | W | 2 credits | 2V | R. Suleiman
851-0585-15L | Complexity and Global Systems Science | W | 3 credits | 2V | D. Helbig, L. Sanders
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “ tipping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, conflicts, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating technosocio-economic-environmental problems, and what data science may contribute to their solution.

Mathematical skills can be helpful

**Course Code:** 851-0252-04L  
**Title:** Behavioral Studies Colloquium  
**Credit:** 2 credits  
**Course Type:** W  
**Prerequisites:**

**Abstract:** This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their research ideas in relation to behavioral science. The colloquium also features invited research talks.

**Objective:** Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages.

**Content:** This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in so far as they have some relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education, Sociology, Modeling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper.

**Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the colloquium. Students interested in giving a talk should contact C. Hölscher before the first session of the semester. Priority will be given to advanced / doctoral students for oral presentations. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.

**851-0252-07L Recent Debates in Social Networks Research**  
**Credit:** 2 credits  
**Course Type:** W  
**Prerequisites:**

**Abstract:** Social Networks research is a highly interdisciplinary fields. For example, scholars in Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics contribute to the development of theories and methods. This course aims at understanding, comparing and structuring recent debates in the field of Social Networks.

**Objective:** Social Networks research is a highly interdisciplinary fields. At the end of this seminar, students will understand and be able to compare different subject-specific approaches to social networks research (e.g., from Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics). They will be familiar with recent publications in the field and be able to critically participate in a number of recent debates. Amongst others, these debates touch upon the co-evolution of selection and influence mechanisms, appropriateness of statistical models, generic mechanisms and features of social networks, models for the analysis of dynamic networks.

**851-0253-00L Embodied Cognition**  
**Credit:** 2 credits  
**Course Type:** W  
**Prerequisites:**

**Abstract:** This seminar offers an introduction to embodiment. Does the representation of thought and emotion depend upon the sensory and motor system? Highlights: the figurative processing of “go” still evokes voltage changes in foot muscles, conceptualizing time activates the eyes to look along a mental time line, abstract causality might still be grounded in motor control, emotion shows in the way we walk.

**Objective:**

Looking at the degree of embodiment in cognition and emotion naturally leads to the question how the minds work. What is the nature of human thoughts and emotions? How deeply are they dependent upon features of our physical body as an agent? Do the sensory and motor system play a physically constitutive role in conceptualizing thought and emotion? We will look at these questions by examining the degree of embodiment in basic thinking types of our mind (space, time, and causality thinking) as well as in abstract thought (e.g., logical thinking) and in emotion processing. As will be discussed, the topic of how the minds works is not only of central importance in the humanities (psychology, linguistics, philosophy, anthropology, education), but is also relevant for parts of the natural and technological sciences (physiology, neurosciences, medicine, computer science, artificial intelligence). Active participation is expected. Each participant can choose a topic for which they will give an oral presentation (about 30 min.) and write a related written report (about 3000 words).

**851-0253-01L Introduction to Cognitive Neuroscience**  
**Credit:** 3 credits  
**Course Type:** W  
**Prerequisites:**

**Abstract:** This will be an introductory course in cognitive neuroscience. We will examine both human neurophysiology and cognitive functioning and explore how the latter is understood by the former. Topics will include brain anatomy and development, cellular mechanisms, CNS methodologies, visual perception, object recognition, memory, hemispheric specialization, and complex cognition.

**Objective:**

The focus will be on the interplay between neural and cognitive systems. The course will have a bias towards “higher” cognitive functions.

Learning objectives and outcomes: the course will have three basic components: (1) the first component will include basics of brain anatomy and development, functioning of cellular mechanisms, and how cellular mechanisms can be modelled as computational processes; (2) the second component will overview CNS methodologies, with an emphasis on MRI techniques; (3) in the third component we will turn to content topics. These will include visual perception, object recognition, memory, hemispheric specialization, and complex cognition. By the end of the course the student will be able to identify the major brain structures, they should be able to explain the functioning of neurons, as relating to the action potential, have an understanding of the methodologies used to generate the various types or results reported in the literature, and for each of the content topics, the student should be able to identify the phenomenon, give examples, and discuss one or two of the main theories explaining it.

**851-0585-00L Rational-Choice-Sociology. Theory and Empirical Applications**  
**Credit:** 2 credits  
**Course Type:** W  
**Prerequisites:**

**Abstract:** Rational-Choice-Theory has become one of sociology’s general theoretical approaches. The seminar concerns itself with major ideas, concepts and questions involved with the development of a theory. The seminar will also include examples of empirical applications from various fields of sociology.

**Objective:**

Attain in-depth knowledge and learn about new aspects of Rational-Choice-Theory and its applications.

**Content**

In collaboration with Prof. Dr. Norman Braun, Dr. Thomas Hinz, University of Munich, and Dr. Axel Franzen, University of Cologne. Rational-Choice-Theory (RCT) has become a general theoretical approach in sociology. Recent progress in social sciences and game theory has triggered the theoretical development of RCT. The seminar will be concerned with important new ideas, concepts and questions of theory building. In addition, the seminar will illustrate empirical applications which cover broad areas in sociology: marriage and divorce, fertility, consumer behavior, labor market processes and exchange in social networks.

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Autumn Semester 2015  
Page 579 of 1432
<table>
<thead>
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<th>Course Code</th>
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<td>851-0585-04L</td>
<td>Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB</td>
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<tr>
<td>851-0585-41L</td>
<td>From Computational Social Science to Global Systems Science</td>
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<tr>
<td>851-0585-34L</td>
<td>Political Violence</td>
</tr>
<tr>
<td>851-0591-00L</td>
<td>Digital Sustainability in the Knowledge Society</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**
Due to a very limited number of possible participants please register early with the assistant at the Chair of Sociology irene.urbanek@soz.gess.ethz.ch.
Doctoral students and post-doctoral students will be given priority.
The seminar will be held in German.
Participants are expected to write a paper or give a presentation.

**Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems with particular nature.

**Numerous German and English literature will be supplemented and made available online.**

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

**Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.**

**The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work, (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work.**

**Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.**

**They should also be able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.**

**Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the emergence of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.**

**The goal is to deliver clear concepts and typologies which help for a better understanding of the various forms of political violence whether in pure form or mixed with other forms of conflict. The focus is on making known a large number of empirical theories.**

**A fresh mind, some historical and contemporary knowledge, experience in controlled explanations.**

**Graded essay, own choice of topic according to the syllabus and upon consulting the lecturer. Submission of the essay is 31st January, 2016.**

**How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g., Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.**

**At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/*"free" models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff. After the lecture, you should (hopefully) be able to**
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)
Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected sociological topics. The goal of the course is to provide participants with an understanding of working practice in empirical sociology and comparative cultural sciences.

Problems of the evolutionary perspective within various scientific disciplines, especially anthropology, psychology, empirical social research and comparative cultural sciences.

Number of participants limited to 30.


Other recommended books are:


The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as “knowledge” (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of “intellectual property”, which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetics», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.digisus.info starting from September. Stay tuned.

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the lecture.

Other recommended books are:


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Folgende Themen werden behandelt:


Gruppenarbeiten

- Schriftliche Arbeit in Soziologie (Durchführung einer kleinen empirischen Studie, Konstruktion eines Simulationsmodells sozialer Prozesse oder Diskussion einer vorliegenden soziologischen Untersuchung).

Literatur

Folien der Vorlesung im Internet

051-0811-00L Sociology I W 1 credit 2V C. Schmid

Abstract

Sociology I investigates the relation between social developments and the production of the built environment from a macro-sociological point of view. It examines central aspects of social change, historical and present-day forms of urbanization, and typical examples of models of urbanization.

Objective

This series of lectures should enable students to comprehend architecture in its social context. It approaches the architectural profession from two different angles: macro-sociological and micro-sociological.

Content

Sociology I deals with the macro-sociological point of view, and investigates the relation between social developments and the production of the built environment. In the first part some central aspects of social change are examined in particular the transition from Fordism to Postfordism and from Modernism to Postmodernism, and the interlinked processes of globalization and regionalization. The second part deals with historical and present-day forms of urbanization. Among other aspects treated here are the changed significance of urban-rural contrasts, the processes of suburbanization and periurbanization, the formation of global cities and metropolitan regions, the growth of new urban configurations in centres (gentrification) and on urban peripheries (edge city, exopolis). In the third part these general processes are illustrated by typical models of urbanization.


Abstract

In the last decades, urbanization has become a planetary phenomenon, leading to an intense debate about a new conceptualization of urbanization. This theory seminar aims at giving an introduction into the actual debate on planetary urbanization, into urban theory, theoretical thinking and the work with scientific texts.

Objective

This elective course highlights the sociological perspective on architectural practice and provides an introduction to sociological research. It focuses on two main procedures: on the one hand, a systematic reading and discussion of theoretical texts, and on the other, empirical case studies of social aspects of the production of the built environment. In this course, a wide set of qualitative research methods is used (including various forms of interview, participant observation, image and text analyses). This approach enables students to gain their own experience by dealing with the various participants and constellations in the social field of architecture and building construction, and to familiarize themselves with the approaches and perceptions of various different participants.

Content

In this theory seminar we read and discuss a range of recent papers and book chapters which analyze these new phenomena of planetary urbanization, such as the implosion and explosion of urban regions, the disintegration of contiguous "hinterlands", the emergence of corridor urbanization, the large scale industrialization and urbanization of agricultural areas, the production of extended urban fabrics of logistics, the creation and extension of operational landscapes, as well as processes that lead to the end of the "wilderness" and the urbanization of ocean space.

Literature

The relevant texts will be distributed in the seminar. A very good overview is provided in the following edited volume: Brenner, Neil (ed.): Implosions / Explosions: Towards a Study of Planetary Urbanization. Jovis, Berlin, 2014.

701-1541-00L Multivariate Methods W 3 credits 2V+1U R. Hansmann

Abstract

The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.

Objective

Upon completion of this course, the student should have acquired:

(1) Knowledge on the foundations of several methods of multivariate data analysis, along with the conditions under which their use is appropriate

(2) Skill in the estimation, specification and diagnostics of the various models

(3) Hands-on experience with those methods through the use of appropriate software and actual data sets in the PC lab

Content

The course will begin with an introduction to multivariate methods such as analysis of variance and multiple linear regression, where a metric dependent variable is "explained" by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.

Literature

Will be announced at the beginning of the course.

701-0731-00L Environmental Sociology W 2 credits 2S H. Bruderer Enzler

Abstract

This introductory class in environmental sociology covers different theoretical approaches but the main focus is on recent empirical research on topics such as environmental behavior, environmental concern, social dilemmas, social norms, environmental justice, and risk perception.

Objective

Basic knowledge of environmental sociology
Overview on current fields of research in environmental sociology and their relevance for environmental protection
Basic notion of the structure of empirical research papers in social sciences
The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It aims at getting to know the theoretical and practical conditions of exhibitions as temporary forms of knowledge. We will develop criteria to explore the various aspects and processes related to exhibitions, including: installations of exhibits, display cases, transports devices, exhibition catalogues, exhibition architecture, visitor guidance, spatial arrangements of objects etc.


**Science Research**

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<td>Transdisciplinary Journal Club am Collegium Helvetica</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>G. Folkers, H. von Sass</td>
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<tr>
<td></td>
<td>Where in a field do innovative findings show up? This is a fundamental of discussion for every discipline. But what about problems that cannot be framed within one discipline? In terms of a Transdisciplinary Journal Club individual competences should be gained to lead and follow a scientific discussion beyond disciplinary boundaries.</td>
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<td>- reading and understanding scientific papers beyond disciplinary boundaries</td>
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<td>- gaining language competence to bridge the gap between disciplines</td>
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<tr>
<td>851-0157-00L</td>
<td>Mind and Brain</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Hagner</td>
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<td></td>
<td>In the last 2500 years, the mind-brain relationship has been articulated in various ways. In these lectures, I will explore the scientific and philosophical aspects of this relationship in the context of relevant cultural, historical and technological processes, with a focus on the modern neurosciences, but I will also discuss works of art and literature.</td>
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<td>By the end of this lecture, students should be familiar with essential positions in the scientific and philosophical treatment of questions relating the mind to the brain. It should also become clear that some of the most relevant problems in current neurosciences have a long history.</td>
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<td>851-0157-56L</td>
<td>Avantgarde-Life: Utopia of the 'New Man' Between Science and Technology</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>M. Wulz</td>
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<td>Particularly suitable for students of D-ARCH, D-HEST, D-MTEC.</td>
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<td>At the beginning of the 20th century, the artistic and social avantgarde movements developed visions of a 'New Man' with new modes of perception and within new forms of social life. The seminar deals with the scientific, technological, artistic, pedagogical, and political designs for a new living.</td>
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<td>851-0157-57L</td>
<td>Classics in the History of Science: Approaches, History, Contexts</td>
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<td>3</td>
<td>2S</td>
<td>N. Guettler, M. Studler</td>
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<td>More often than not, classics are known by hearsay; they are quoted, but not read, or re-discovered and re-read selectively, so we can quote them. That holds true for many 'classics' in the history of science, too - texts, that is, which have shaped approaches to, and understandings of, science. The aim of this introductory course is to critically read some of these seminal texts.</td>
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<td>This course is suited for all students with an interest in the history of science and knowledge. Conceived of as an advanced historiographical introduction to the subject, the course is to explore a selection of &quot;classics&quot; in the history of science - some of them well known, others less so. In this course, we shall be as much concerned with the positions and the perspectives on science that were advanced in these various texts as we shall be concerned with the historical circumstances, political meanings and wider cultural contexts of these perspectives.</td>
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<td>851-0157-59L</td>
<td>A Historical Epistemology of Exhibitions</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>M. Pratschke</td>
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Anke te Heesen: Theorien des Museums zur Einführung, Hamburg 2012.

Anke te Heesen, Margarete Vöhringer (Hg.); Wissenschaft im Museum. Ausstellung im Labor, Berlin 2014.


851-0158-00L Living at the Expense of Others. Parasites in the History of Science W 3 credits 2V E. Johach

Number of participants limited to 80.

Abstract
Parasites have a bad reputation. They settle in with other creatures' bodies, they manipulate and deceive them, they live at the expense of others. Such features are not only of biological but also of social, political, and economic importance. The lecture will track the traces of the parasite through the history of biology and medicine and the fields of political economy and cultural theory.

Objective
The course provides insight into the complex and intricate history of the parasite and the various definitions of parasitism. In particular, it will make students aware of the fact that there is no single expert discourse on parasites (such as biology or medicine) which is then transferred to the realm of the social and the political. Instead, it will be considered how and why all these aspects are intertwined when people talk about parasites.

851-0158-01L Science and Wonder W 3 credits 2S E. Johach

Number of participants limited to 30.

Abstract
Wonders seem to be perfectly incompatible with science: Superstition and ignorance here, exactness and certitude there. In the seminar we will study this conflictive relation in more detail. Texts will cover a broad historical spectrum ranging from pre-modern cabinets of wonder to the anti-wonder polemics in the 19th century to the current dispute on Intelligent Design.

Objective
Following the notions of "wonder" and the "wonderful" as recurrent themes students will get an overview of the history of the sciences and their specifically modern self-conception. They will gain the expertise to understand arguments and conflicts out of their particular historical context and thereby get inside into the historical variability of objectivity and scholarly standards.

701-0771-00L Environmental Conciousness and Public Relations W 2 credits 2G R. Locher

Number of participants limited to 60.

Sign in until 24.09.2015.
Please describe your expectations. Why do you want to attend this special topic? Do you have any pre-information about the integral model? Do you have any practical experience in environmental communication?

Abstract
"Environmental Conciousness and Public Relations" shows how to communicate about environment and sustainability successfully. We look at campaigns, exhibitions and other public relations measures to learn, how to design and realize good communication.

Objective
You learn how to handle tools and concepts in environmental communication. And you can evaluate communication projects. We also discuss the evolution of consciousness.

Content
- Methods and tools in environmental communication.
- Marketing mix
- Examples of campaigns, events, print products, media relations.
- Integral sustainability

Lecture notes
Handouts
- Integral Vision; Ken Wilber, 2005

Prerequisites / notice
We will discuss new trends in environmental communication with the focus on integral solutions.

701-0785-00L Environmental and Science Communication W 4 credits 2V M. Schäfer

The course gives an introductory overview in research questions, theoretical perspectives and empirical results of science communication and environmental communication. They will be illustrated by concrete examples and via lectures from external guests. .

Objective
Goals: Learning to understand structures and processes of environmental and science communication, becoming more sensitive for problems of science public relations, getting an insight into public debates about environmental issues. Methods: Case studies, invitation of media practitioners and experts, discussions, lectures on key theoretical concepts of communication. Topics: Concrete communication instruments like media conferences, theoretical perspectives of public relations, basic principles and examples of information campaigns, environment and science as media topics, functions and structures of science communication, relations between science, media and politics.

Content
I. Introduction
- Topics: Environment, Science, Risks, Media
- Forms, Functions, Effects of Public and Mass Communication

II. Stakeholders and their Public Relations Efforts
- Public Relations and Science PR: Theoretical Perspectives, Instruments

III. Science and Environmental Issues in the Media
- Forms and Functions of Science Journalism
- Problems of Selection, Interpretation, Quality
- Media Content Analysis
- Online Communication

IV. Uses and Effects of Science and Environmental Communication
- Extent of Media Use
- Effects on Knowledge, Risk Perceptions, Environmental Attitudes
- Effects on Science itself

Lecture notes
Literature and powerpoint presentations will be provided on the OLAT platform.
History of Art and Architecture I

- The lecture conveys historical knowledge about architecture and art as well as methodical knowledge as a preparation for the independent handling of historical sources and scientific literature.
- The history of art and architecture is part of our reality: it confronts us in the historically shaped environment of the city and plays an essential role in the creation of architecture. The historical lectures are therefore part of the fundamental courses of the undergraduate programme in architecture. On the basis of cultural and art-historical research the courses impart knowledge about architecture and art from ancient times to the present. At the same time they sharpen the perception for the conditions and capabilities of building activity in history. Moreover, they convey methodical knowledge and technical language skills and are meant as a preparation for the independent handling of historical sources and scientific literature.
- The first one-year course aims at these goals in the form of exemplary epoch representations which through light upon the historical continuities. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

History of Art and Architecture III

- The two-semester course offers an introduction to the history and theory of architecture from the industrial revolution up to now. Based on current questions a variety of case studies will be discussed.
- The subject of this lecture course is the history and theory of architecture since the beginning of the 19th century up to today. The aims are to convey an overview on crucial events, works of art, buildings and theories since the beginning of the 19th century up to today. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.
Objective

This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.

Content

In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.

01. Introduction to the discipline and method: The history of urban design as a historical project

02. Athens and Rome in the ancient world: Myth, selfportrayal and speculation

03. From the spirit of equality to the colonial module: Greek and Roman City foundings

04. From the urban ideal to new cities in the Middle Ages and the Renaissance

05. Baroque strategies: The new organisation of Rome under Sixtus V, the production of Versailles under Louis XIV and the invention of St. Petersburg

06. The city between Absolutism and Enlightenment: baroque defence-designs, the European colonization of the American continent and the reconstruction of Lisbon

07. Ideology and specutation after the Glorious Revolution: landscapegardens and urban figurations in England from 1650-1850

08. Between modernization, Grandeur and repression: Embellishment in Paris from 1750-1830

09. The construction of the bourgeois city: Georges-Eugène Haussmann transforms Paris into the capital of the 19th century

10. Architectural insertion and plan for the expansion of the city: From the Berlin of Karl Friedrich Schinkel to James Hobrecht

11. Neobusolute power, bourgeois self-confidence and Marxian Idealism: The Viennese Ringstrasse and Ildefonso Cerdas Ensanche for Barcelona

Lecture notes

The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30.-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

Literature

Further recommended literature to consult is listet within the script.

History of Urban Design from antiquity to the 19th century

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Duration</th>
<th>Instructor</th>
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<tr>
<td>851-0724-00L</td>
<td>Property Law for Geometers: Land Registry and Geoinformation Law</td>
<td>2</td>
<td>2V</td>
<td>M. Huser</td>
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<td>Particularly suitable for students of D-ARCH, D-BAUG, D-USYS</td>
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<td>Overview of the legal norms of land registry and surveying law.</td>
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<td>Lecture notes</td>
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<td>Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014</td>
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<td>- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005</td>
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<td>- Dieter Zobl, Grundbuchrecht, Zürich 1999</td>
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<td>- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglipher Rechte, in ZBGR 2013, 238 ff.</td>
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<td>- Meinrad Huser, Datenschutz bei Geodaten</td>
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<td>Prerequisites / notice</td>
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<td>Requirements: Property Law (12-722)</td>
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851-0705-02L  | Environmental Law: Topics and Case Studies                            | 2       | 2S       | C. Jäger   |
|             | Number of participants limited to 20.                                 |         |          |            |
|             | Prerequisites: Environmental Law: Conceptions and Fields ((851-0705-01L) offered in spring semester. |
|             | Particularly suitable for students of D-ARCH, D-BAUG, D-USYS          |         |          |            |
|             | Abstract                                                              |         |          |            |
|             | This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters. |
|             | Objective                                                             |         |          |            |
|             | The aim of this workshop is to equip students with legal skills and methods to solve or treat problems and questions of the environmental law and foster the understanding on the possibilities and limits of legal problem-solving. The students choose an inquiry with practical relevance. To this end they work out the legal basis demonstrating a legal correct solution or approach to a solution. In doing so, students will get to know legal methods and research possibilities. |
At the beginning of the workshop the students are introduced to the legal methods and sources as well as the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a minimum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

**Reflections on Design Processes**

Lecture notes: Den Studierenden werden Unterragen zur juristischen Methoden- und Quellenlehre sowie zum Inhalt und Ablauf des Kurses zu Beginn der Veranstaltung kostenlos abgegeben.

Literature: Rechtsgrundlagen, Literatur und Gerichtsentscheide werden themenspezifisch selber recherchiert, unter Mithilfe und Beratung des Dozenten.

Prerequisites / notice: Die Veranstaltung erfordert die Bereitschaft, sich aktiv und selbständig mit einer selbstgewählten Fragestellung oder einem eigenen Fallbeispiel aus dem Gebiet des Umweltrechts und allenfalls aus Schnittstellengebieten auseinanderzusetzen. Damit die Interaktivität und die Begeisterung der Teams gewährleistet werden kann, ist die Teilnehmerzahl auf maximal 16 Personen beschränkt. Es handelt sich um eine Vertiefungsveranstaltung. Der Besuch der Vorlesung "Umweltrecht: Konzepte und Rechtsgebiete" (851-0705-01) ist Voraussetzung.

**851-0707-00L** Space Planning Law and Environment W 2 credits 2G O. Bucher

**Abstract**

System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.

**Objective**

Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.

**Content**


**Lecture notes**

Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999

Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 5.A., Bern 2008

**851-0252-01L** Human-Computer Interaction: Cognition and Usability W 3 credits 2S C. Hölscher, I. Barisic, S. Ogrijanovic

**Number of participants limited to 20.**

**Abstract**

This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOEMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

**Objective**

This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOEMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

**851-0252-03L** Cognition in Architecture - Designing Orientation and Navigation for Building Users W 3 credits 2S V. Schinazzi, B. Emo Nax, C. Hölscher

**Abstract**

How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.

**Objective**

Taking the perspective of building occupants and visitors, is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they memorize the environment and how they find their way from A to B. Students will also learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking and behavior simulation for design. Students will reflect on the roles of designers and other stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture / planning, engineering, computer science and behavioral science as well as anybody interested in the relation between design and cognition. Architecture students can obtain course credit in "Vertiefungsfach" or "Wahlfach".

**851-0253-02L** Reflections on Design Processes W 3 credits 2S V. Goel, C. Hölscher

**Abstract**

This will be a seminar on design processes. We will review the body of work directed at understanding design processes from the 1950s to the present time. The students will be expected to prepare for and lead the presentations for some of the topics and write a final paper.

**Objective**

Designing artifacts is a critically important, if not unique, human cognitive activity. While we have engaged in design activity since we have been human, it has only been an object of study for the past 50 years. The initial focus during the 1960s was on "design methodologies". This body of work, motivated by large, technically sophisticated, geographically dispersed projects like the Polaris missile project, sought to develop an analytic, mathematically based, teachable doctrine about the design process that would serve the same role for design as the "scientific method" served for science. During the 1980s interest shifted from a normative approach to a descriptive approach, focusing on the cognitive and computational processes of designers. More recently, several researchers are using neuropsychological methodologies to understand the design process.

Learning outcomes: to understand the design process from a normative methodological perspective, and descriptive computational, cognitive, and neural perspectives.

Learning outcomes: By the end of the seminar the student should be familiar with these literatures, should be able to discuss relative strengths and weaknesses, and identify what each has contributed to our ability to design, and to our understanding of the design process itself.

**851-0157-55L** Avantgarde-Life: Utopia of the 'New Man' Between W 3 credits 2S M. Wulz

At the beginning of the 20th century, the artistic and social avantgarde movements developed visions of a 'New Man' with new modes of perception and within new forms of social life. The seminar deals with the scientific, technological, artistic, pedagogical, and political designs for a new living.

The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It focuses on the correlation of the contemporary scientific and technological developments and the conceptions of a 'New Man'. The discipline of psychotechnics together with scientific and technological designs of living and working environments formulated visions of new and enhanced ways of human living and perception. In the seminar, we will examine the utopian visions of life in the avantgarde movements. Touching upon the fields of the life sciences, economics, management, progressive education, architecture, and art we will reflect the diverse relations between science, technology, and human living.

A Historical Epistemology of Exhibitions

The seminar provides an introduction to exhibitions as epistemic practices. By means of various research approaches and examples from historical and current exhibitions we will discuss how knowledge is created by temporary spatial constellations of exhibited objects and the ways exhibitions act as laboratories of ideas.

The seminar aims at getting to know the theoretical and practical conditions of exhibitions as temporary forms of knowledge. We will develop criteria to explore the various aspects and processes related to exhibitions, including: installations of exhibits, display cases, transporting devices, exhibition catalogues, exhibition architecture, visitor guidance, spatial arrangements of objects etc.

Using selected historical and current examples, we will discuss different formats of exhibitions that range from trade fair booths to laboratory exhibitions, exhibitions in art museums as well as in science and natural museums. Being a specific humanistic way of creating knowledge experimentally we will pay particular attention to exhibitions that deal with topics at the intersection of the sciences and the humanities, thus acting as agents in the debate on the Two Cultures.

The seminar deals with hot topics of the history of technology since the 1960s. Sharing of computertime, software and data will be discussed as a crucial offer and problem of late modernity.

Using selected historical and current examples, we will discuss different formats of exhibitions that range from trade fair booths to laboratory exhibitions, exhibitions in art museums as well as in science and natural museums. Being a specific humanistic way of creating knowledge experimentally we will pay particular attention to exhibitions that deal with topics at the intersection of the sciences and the humanities, thus acting as agents in the debate on the Two Cultures.

The seminar aims to develop the students' ability to critically read and assess historic texts.

The course wants to develop the students' ability to critically read and assess historic texts.

A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.

The seminar is fully booked!

The seminar is fully booked!

The seminar is fully booked!

The seminar is fully booked!
### 851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law

* Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

#### Abstract
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

#### Objective
Overview of the legal norms of land registry and surveying law.

#### Content
Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the process of registration with the Land Register, legal problems of land surveying, the reform of official surveying, liability of the geo-mater. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

#### Lecture notes
Abgegebene Unterlagen: Skript in digitaler Form

#### Prerequisites / notice
The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

### 851-0705-02L Environmental Law: Topics and Case Studies

* Number of participants limited to 20.

#### Prerequisites
Property Law (12-722)

#### Abstract
This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.

#### Objective
The aim of this workshop is to equip students with legal skills and methods to solve or treat problems and questions of the environmental law and foster the understanding on the possibilities and limits of legal problem-solving. The students choose an inquiry with practical relevance. To this end they work out the legal basis demonstrating a legal correct solution or approach to a solution. In doing so, students will get to know legal methods and research possibilities.

#### Content
At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

#### Lecture notes
Den Studierenden werden Unterlagen zur juristischen Methoden- und Quellenlehre sowie zum Inhalt und Ablauf des Kurses zu Beginn der Veranstaltung kostenlos abgegeben.

#### Literature
Rechtsgrundlagen, Literatur und Gerichtsentscheide werden themenspezifisch selber recherchiert, unter Mithilfe und Beratung des Dozenten.
Further recommended literature to consult is listed within the script. Acquirement of basic knowledge of the history of art and architecture, resp. of methodical basic knowledge of historical working.

Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.


Lecture notes

Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999

Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 5.A., Bern 2008

**051-0363-00L**

**History of Urban Design I**

The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the historical plannings and methods of European cities. Each specific urban development will be presented within a broader context.

In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.

01. Introduction to the discipline and method: The history of urban design as a historical project

02. Athens and Rome in the ancient world: Myth, selfportrayal and speculation

03. From the spirit of equality to the colonial module: Greek and Roman City foundings

04. From the urban ideal to new cities in the Middle Ages and the Renaissance

05. Baroque strategies: The new organisation of Rome under Sixtus V, the production of Versailles under Louis XIV and the invention of St. Petersburg

06. The city between Absolutism and Enlightenment: baroque defence-designs, the European colonization of the American continent and the reconstruction of Lisbon

07. Ideology and speculation after the Glorious Revolution: landscapegardens and urban figurations in England from 1650-1850

08. Between modernization, Grandeur and repression: Embellishment in Paris from 1750-1830

09. The construction of the bourgeois city: Georges-Eugène Haussmann transforms Paris into the capital of the 19th century

10. Architectural insertion and plan for the expansion of the city: From the Berlin of Karl Friedrich Schinkel to James Hobrecht

11. Neoabsolute power, bourgeois self-confidence and Marxian Idealism: The Viennese Ringstrasse and Ildefonso Cerdas Ensanche for Barcelona

Lecture notes

The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30.-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

Further recommended literature to consult is listed within the script.

**Literature**

**051-0331-00L**

**History of Art and Architecture I**

The lecture conveys historical knowledge about architecture and art as well as methodical knowledge as a preparation for the independent handling of historical sources and scientific literature. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

The history of art and architecture is part of our reality: it confronts us in the historically shaped environment of the city and plays an essential role in the creation of architecture. The historical lectures are therefore part of the fundamental courses of the undergraduate programme in architecture. On the basis of cultural and art-historical research the courses impart knowledge about architecture and art from ancient times to the present. At the same time they sharpen the perception for the conditions and capabilities of building activity in history. Moreover, they convey methodical knowledge and technical language skills and are meant as a preparation for the independent handling of historical sources and scientific literature.

The first one-year course aims at these goals in the form of exemplary epoch representations which through light upon the historical continuities. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and have practised these in small case studies.

The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.
Central Questions in Bioethics

Particularly suitable for students of D-BIOL, D-CHAB, D-HEST, D-MATL, D-MAVT

Abstract
Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like "Protect the dignity of the living being!", or "Respect a person's self-determination"? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account.

Objective

Literature
1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.

Philosophy of Biology

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

Abstract
The philosophy of biology deals with concepts and problems that occur specifically while dealing with living entities. Accordingly, it covers the historical as well as systematic aspects of concepts like gene or species, or theories explaining diversity or stability, competitive or cooperative action. Another important topic is the role of technology while affording biological objects.

Objective
The overarching objective of this seminar is to get an impression of the specificity of biological problems and to develop an appropriate philosophical sensitivity. Accordingly, philosophical traditions in biology will be discussed, just as the application of the history of concepts in the context of biology. The seminar reader will consist of contributions of biologists as well as philosophers of biology. Besides the basic concepts in biology such as gene, species, evolution, or diversity, we will be also reflecting on the relationship between technology, experimenting, and biological objects. Depending on the interests of the seminar participants, the examples to be discussed may be chosen from systems biology, molecular or synthetic biology, ecology or else.

Research Ethics

Particularly suitable for students of D-BIOL, D-CHAB, D-HEST

Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student’s ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry
---------------------------------------

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

851-0148-02L Manifolds and Individuation in Mathematics and Philosophy 3 credits 2S T. Böhm
Number of participants limited to 40. Particularly suitable for students of D-BIOL, D-MATH, D-PHYS
Abstract
Manifolds and individuation are concepts which allow to reconsider notorious problems such as the relationship between general and particular, substance and modi, physical processes and persons. They may incorporate heterogeneous elements as needed to overcome traditional categories and classifications, and also describe processes leading to the existence of things.

Objective
The students should become familiar with some conceptual possibilities to recognise and deal with structures across the usual division of subjects. The problem areas are discussed on the basis of texts of various mathematicians and philosophers, with a wide range of applications such as psychology and life sciences.

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>851-0125-51L</td>
<td>Man and Machine</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Hampe, D. A. Strassberg</td>
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<td></td>
<td>Particularly suitable for students of D-CHAB, D-HEST, D-MAVT, D-MAVL</td>
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<tr>
<td>Abstract</td>
<td>The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.</td>
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<td>Objective</td>
<td>On the one hand models of machines had a heuristic value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these models were always criticised, sometimes polemically, because they are supposedly not adequate for man. Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.</td>
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<tr>
<td>851-0125-52L</td>
<td>Central Questions in Bioethics</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>L. Wingert</td>
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<td>Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like “Protect the dignity of the living being”, or “Respect a person’s self-determination”? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account.</td>
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Literature
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<tr>
<td>851-0145-04L</td>
<td>History and Philosophy of Pharmacy</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>S. Baier</td>
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<td></td>
<td>Particularly suitable for students of D-CHAB</td>
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<tr>
<td>851-0738-03L</td>
<td>Protecting Inventions in Chemistry</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>C. Soltmann</td>
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<td></td>
<td>Particularly suitable for students of D-CHAB</td>
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<tr>
<td>Abstract</td>
<td>The lecture gives students of chemistry-related degree programs an overview of the options to protect inventions and the underlying investments in research and development. The lecture aims to put the participants in a position to be able to use this know-how in the workplace.</td>
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Objective

Research and development play an important role in chemistry-related technology sectors, such as inorganic chemistry, pharmacy or food chemistry.

Investments in the development of new substances and active component in these sectors are traditionally secured by patents because publicly known inventions, generally chemical substances, may easily be reproduced by others.

In the last years, the know-how about intellectual property has become increasingly important for chemists and engineers. Both in the production process and in the distribution sector, chemists and engineers are increasingly concerned with questions related to patenting inventions and the use of patent information. As more than three-quarters of all publicly available technical information is reportedly available only in patents, it is more and more important for researchers and engineers to be capable of extracting relevant information from the flood of patents.

Patents are not only a measure to protect investments and inventions in chemistry-related sectors but also an important source of information about competitors and potential cooperation partners, about the development of markets and the risks of infringing others’ patents. Accordingly, the know-how about patents and patent information has also become a key qualification on the strategic level in companies and in the area of research.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.
- Special aspects of protecting inventions in chemistry-related sectors, including polymorphs and inventions in the field of nanotechnology.

The seminar contains practical exercises on the use and search of patent information in chemistry-related sectors. Basic know-how on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

Prerequisites / notice

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, biotechnology, chemical engineering, chemistry, food science, pharmaceutical sciences.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' will be offered, which is coordinated to the needs of students in these degree programs.

Research Ethics

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

The main goal of this course is to enhance the student’s ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
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- Why arguments? What is a good argument? The structure of (moral) arguments;
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II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
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- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

860-0006-00L Statistical Data Analysis • W 3 credits 3G M. Höglinger, I. Günther, K. Harttgen

Number of participants limited to 20.

Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and argumentation to be found within the field of environmental ethics and will have practised these in small case studies.

- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-sectional topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

Summaries of the individual session will be distributed, including the most important theories and keywords; reading list.

In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Hüppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, Zürich 2010 (to be published Autumn 2010).

Literature:
- Andreas Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O'Neil et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

Generel introductions:
- Marcus Diwiell et. al (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al (Hrsg.), Grundtexte der gegenwärntiger tier- und bioetischen Diskussion 1997
- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003

The procedure for accumulating CP will be explained at the start of term.

I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

This course introduces students to key statistical methods for analysing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

- have a sound understanding of linear and logit regression
- know some basics about regression models for multinomial, ordered, or censored response variables, as well as for count data
- know strategies to test causal hypotheses using regression analysis with experimental and quasi-experimental methods
- are able to formulate and implement a regression model for a particular research question and a particular type of data
- are able to critically interpret results of a regression model, in particular, regarding causal inference

The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinomial or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.
Avantgarde-Life: Utopia of the 'New Man' Between

Introduction to Health Economics and Policy

A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.

3 credits


Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical
decision, principles like "Protect the dignity of the living being!", or "Respect a person's self-determination"? Besides answering such
questions, the social, scientific and political processes linked with biotechnologies should be taken into account.

Dürfen Embryonen unter dem Aspekt selektiert werden, ob sie als Rettungsgeschwister geeignet sind, deren Zeitgewebe einem schon
geborenen anderen Kind durch Implantation das Leben retten kann? Soll die Forschung auch fließen des irdischen, die das menschliche
Gedächtnis teilweise auslöschten und damit zum Beispiel traumatische Erlebnisse beseitigen können? Spricht wirklich mehr gegen
Hirndoping als gegen Kaffeekonsum? Darf es Patente auf menschliche Stammzellen geben? Das sind Fragen der Bioethik.

Der Kurs hat das Ziel, einige der wichtigsten bioethischen Fragen zu erforschen.

Es sollen normative Prinzipien identifiziert werden, die oft faktisch bioethischen Entscheidungen zu Grunde liegen.

Und es sollen überzeugende Prinzipien ermittelt werden.

Zugleich sollen die Teilnehmer Kenntnisse erwerben über die Entwicklungen in zeitgenössischen Gesellschaften westlichen Typs (mit
individuellen Grundrechten, kapitalistischer Marktwirtschaft und systematische wissenschaftlicher Forschung), die mit der Dynamik
von Biotecniken zusammenhängen.

Literature:

1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.

851-0157-56L Avantgarde-Life: Utopia of the 'New Man' Between

Science and Technology

Particularly suitable for students of D-ARCH, D-HEST, D-MTEC.

W 3 credits 2S M. Wulz

Abstract

The seminar ist fully booked!

Objective

At the beginning of the 20th century, the artistic and social avantgarde movements developed visions of a 'New Man' with new modes of
perception and within new forms of social life. The seminar deals with the scientific, technological, artistic, pedagogical, and political
designs for a new living.

851-0549-12L Sharing. The History of an Attractive Technology

Science and Technology

Particularly suitable for students D-ARCH, D-BAUG, D-HEST, D-INFK, D-ITET, D-MAYT, D-MATL

W 3 credits 2S D. Gugerli

Abstract

The seminar deals with hot topics of the history of technology since the 1960s. Sharing of computertime, software and data will be
discussed as a crucial offer and problem of late modernity.

Objective

The course wants to develop the students ability to critically read and asses historic texts.

Lecture notes

A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.

363-1027-00L Introduction to Health Economics and Policy

W 3 credits 2V W. Mimra

Abstract

Health expenditures constitute about 10% of GDP in OECD countries. Extensive government intervention is a typical feature in health
markets. Risk factors to health have been changing with growing importance of lifestyle factors such as smoking, obesity and lack of
physical activity. This course gives an introduction to the economic concepts and empirical findings in health economics.

Objective

The course gives an introduction to the economic concepts and empirical findings in health economics to enhance students
understanding of how health care institutions and markets function.

Content

The course gives an introduction to the economic concepts and empirical findings in health economics to enhance students understanding
of how health care institutions and markets function. First, the three important decisions made by individuals will be analyzed: What
determines the health behaviors, like the intensity of preventive measures like sport, that an individual undertakes? What types and amount
of personal health care services does an individual demand? How much health insurance coverage will be purchased?

In a second part, the major participants on the supply side of health care markets - physicians, hospitals, nurses and pharmaceutical
manufacturers - will be discussed. E.g., how important are financial incentives in the choice of medicine as a career, specialty choice and
practice location? What does it mean and imply that a physician is an agent for a patient? How do pharmaceutical firms decide on
investments in new products and how can public policy encourage pharmaceutical innovation?

The choices made by societies about how health care services are financed and about the types of organizations that supply health care
will be addressed in a third part. One important choice is whether a country will rely on public financing of personal health care services or
encourage private health insurance markets. How could and should a public health insurance system be designed? What health care
services should be included or excluded from a public system? Another important choice is whether a society relies on government
provision of health care services, private provision by not-for-profit or for-profit organizations or some combination. The advantages and
disadvantages of the alternatives will be discussed to provide a framework for analyzing specific types of health care systems.

Literature


851-0180-00L Research Ethics

Particularly suitable for students of D-BIOL, D-CHAB, D-HEST

W 2 credits 2G G. Achermann

Abstract

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical
sciences.
Objective

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.

Content

I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...; Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties); consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes

Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.
The objective is knowing and understanding key legal concepts relevant for doing e-business, particularly understanding how e-business is regulated by law nationally and internationally, how contracts are concluded and performed electronically, which rules have to be obeyed when implementing online projects and undertaking information technology activities.

Particularly suitable for students of D-INFK, D-ITET, D-MAVT, D-MATL.

Objection

Students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay/report will be required (details to be specified in the introductory session of the course).

Lecture notes

A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.

Data: 06.12.2018 13:04 Autumn Semester 2015 Page 600 of 1432

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses how various interest groups influence the methods of production, distribution, and use of digital resources. The course discusses how various interest groups influence the methods of production, distribution, and use of digital resources.

Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff. After the lecture, you should (hopefully) be able to:

1. characterize the nature of digital goods vs. physical goods
2. critique the basic concepts of copyright and patent rights
3. explain the political/legal and economic differentiation between proprietary and open approaches to the production and use of digital goods
4. transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

851-0591-00L Digital Sustainability in the Knowledge Society

<table>
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<tr>
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<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>M. M. Dapp</th>
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</thead>
<tbody>
<tr>
<td>Particularly suitable for students of D-INF, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS</td>
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</table>

### Content

**Technical reality:** Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. "Digitization plus Internet" allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, - piracy - and - file-sharing - are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparative to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g., scientific knowledge, music).

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.digitus.info starting from September. Stay tuned.
Content of the following books is covered (PDFs freely available online):

Other recommended books are:
1 (general) Chris DiBona et al., Open Sources. Voices from the Open Source Revolution, O'Reilly, 1999.

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the lecture.

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB
Number of participants limited to 70.

Content
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Lecture notes
The lecture slides will be presented on the course web page after each lecture.

Literature

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

Prerequisites / notice
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0585-41L From Computational Social Science to Global Systems Science

Number of participants limited to 100.

Abstract
The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work. (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work. Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

They should also be able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

851-0549-00L WebClass Introductory Course History of Technology

Number of participants limited to 200.

Abstract
WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Objective
Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.

Content

Lecture notes

Literature
https://www.tg.ethz.ch/de/programme/

Prerequisites / notice

Weitere Informationen unter https://www.tg.ethz.ch/de/programme/

860-0006-00L Statistical Data Analysis

Number of participants limited to 20.

Content
Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

They should also be able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.
Digital Sustainability in the Knowledge Society

The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinomial or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

**D-ITET**

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
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<td>851-0591-00L</td>
<td>Digital Sustainability in the Knowledge Society</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
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</tbody>
</table>

**Abstract**

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

**Objective**

- have a sound understanding of linear and logit regression
- know some basics about regression models for multinomial, ordered, or censored response variables, as well as for count data
- know strategies to test causal hypotheses using regression analysis with experimental and quasi-experimental methods
- are able to formulate and implement a regression model for a particular research question and a particular type of data
- are able to critically interpret results of a regression model, in particular, regarding causal inference

**Content**

The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinomial or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

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**Data:** 06.12.2018 13:04

**Autumn Semester 2015**
This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

Objective
The seminar deals with hot topics of the history of technology since the 1960s. Sharing of computertime, software and data will be discussed as a crucial offer and problem of late modernity.

Objective
The course wants to develop the students ability to critically read and asses historic texts.

Lecture notes
A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.
Simulating Social Systems with MATLAB
Number of participants limited to 70.

Particularly suitable for students of D-MAVT, D-INFK, D-ITET, D-MTEC, D-PHYS.

Content
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Lecture notes The lecture slides will be presented on the course web page after each lecture.

Literature

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

Prerequisites / notice The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0585-41L
From Computational Social Science to Global Systems Science
Number of participants limited to 20.

Abstract
The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work, (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work.

Objective
Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

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Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

851-0549-00L
WebClass Introductory Course History of Technology
Number of participants limited to 100.

Abstract
WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Objective
Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know the basics of research and practices of the field.

Content


Literature
https://www.tg.ethz.ch/de/programme/

Prerequisites / notice

Weitere Informationen unter https://www.tg.ethz.ch/de/programme/

851-0735-10L
Business Law
Number of participants limited to 70.

Abstract
The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.

Objective
The students shall obtain the following competence:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution.
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.

Lecture notes
A comprehensive script will be made available online on the moodle platform.

851-0594-00L
International Environmental Politics
Number of participants limited to 70.

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

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

Number of participants limited to 70.

Abstract
The students shall obtain the following competence:
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- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.

Lecture notes
A comprehensive script will be made available online on the moodle platform.
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

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

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

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

Lecture notes: Slides and teaching material will be made available at www.ib.ehtz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your ETH username and password to access the material.

Literature: See www.ib.ehtz.ch (teaching, materials)

Prerequisites / notice: Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester.

The rules of the exam are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The workload for this course is approx. 120 hours (all inclusive).

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<th>Credits</th>
<th>Lecture Hours</th>
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<td>The Role of Intellectual Property in Daily Routine</td>
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<td>2V</td>
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</table>

Abstract: The lecture gives engineering students an overview of the basic aspects of intellectual property. The lecture aims to make participants aware of the various methods of protection and to put them in a position to be able to use this knowledge in the workplace.

Objective: In recent years, knowledge about intellectual property has become increasingly important for engineers. In both production and distribution as well as in research and development, engineers are increasingly being confronted with questions concerning the patenting of inventions and the utilisation of patent information. With up to 80% of publicly-available technical information being stored in patent databases only, it is of great importance for engineers to know the basics of the patent system and to be in a position to be able to extract relevant information from the flood of patent information available. This relates to daily work in industry as well as in research, where protecting inventions has gained in importance.

Prerequisites / Notice: Patents are also an important source of information - from competitors and potential cooperation partners to the development of markets and the risk of coming into conflict with third party IP rights. Respectively, a knowledge of patents has also become a key qualification at a company's strategic level.

The seminar is customised to the needs of engineers. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.

Prerequisites / Notice: The seminar contains practical exercises on the use and research of patent information. Basic knowledge on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

For students of chemistry-related degree programs, the lecture ‘Protecting inventions in chemistry’ will be offered, which is coordinated to the needs of students in these degree programs.

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<td>The Economics of Climate Change</td>
<td>3</td>
<td>2V</td>
</tr>
</tbody>
</table>

Abstract: Climate change is one of the most pressing issues that governments and the global community have to face. This course outlines the problem of climate change and discusses the economic solutions to combating climate change. This course has a number of objectives: (i) to outline the problem of climate change; (ii) to discuss and compare the theoretical economic solutions to combating climate change; (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.

Prerequisites / Notice: This course is particularly suitable for students of D-ITET, D-MATH, D-MATL, and D-USYS.

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecture Hours</th>
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<tbody>
<tr>
<td>851-0252-02L</td>
<td>Introduction to Cognitive Science</td>
<td>3</td>
<td>2V</td>
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</table>

Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended.
The lectures provide an overview of the foundations of cognitive science and investigate processes of human cognition, especially perception, learning, memory and reasoning. This includes a comparison of cognitive processes in humans and technical systems, especially with respect to knowledge acquisition, knowledge representation and usage in information processing tasks.

Objective
Cognitive Science views human cognition as information processing and provides an inter-disciplinary integration of approaches from cognitive psychology, informatics (e.g., artificial intelligence), neuroscience and anthropology among others. The lectures provide an overview of basic mechanisms of human information processing and various application domains. A focus will be on matters of knowledge acquisition, representation and usage in humans and machines. Models of human perception, reasoning, memory and learning are presented and students will learn about experimental methods of investigating and understanding human cognitive processes and representation structures.

851-0738-00L

Intelligent Property: Introduction

Abstract
The course provides an introduction to Swiss and European intellectual property law ( trademarks, copyright, patent and design rights).

Objective
Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

851-0585-15L

Complexity and Global Systems Science

Abstract
This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

Objective
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

Content
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at "tipping points", multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or "tragedies of the commons" such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating technoo-economic-environmental problems, and what data science may contribute to their solution.

Prerequisites / notice
Mathematical skills can be helpful.

851-0300-94L

Combinatorics: History of a Method Between Mathematics and Literature

Abstract
Combinatorics is a procedure shared by various disciplines. In mathematics it concerns the calculation of quanta and probabilities, in philosophy the creation of encyclopedic knowledge, in mysticism the achievement of ecstatic experience, in literature, finally, experimental writing. This course investigates these different forms of combinatorics.

Objective
- comparative understanding of combinatorics as a transcultural and transdisciplinary procedure to generate knowledge
- combinatorics in theology, mysticism and occultism
- combinatorics in philosophy and the natural sciences
- combinatorics in literature and literary theory

Content
Kombinatorik, die Verknüpfung von Elementen, tritt als ein Verfahren in unterschiedlichen Disziplinen und Bereichen des Wissens auf: In der Mathematik, wo man sie zuerst vermutet, ermöglicht sie die Berechnung von Anzahlen und Wahrscheinlichkeiten. Zugleich spielt sie eine grosse Rolle in der Philosophie (als ein Verfahren zur Erzeugung eines enzyklopädischen Wissens), in der Mystik (zur Erfahrung ekstatischer Erfahrung) und in der Literatur (als ein experimentelles Schreibverfahren). In dem Seminar werden diese vielfältigen Formen und Funktionen von kombinatorischen Verfahren zwischen mathematischer, philosophischer, mystischer und ästhetischer Anwendung verglichen und analysiert.

851-0148-02L

Manifolds and Individuation in Mathematics and Philosophy

Abstract
Manifolds and individuation are concepts which allow to reconsider notorious problems such as the relationship between general and particular, substance and modi, physical processes and persons. They may incorporate heterogeneous elements as needed to overcome traditional categories and dualisms, and also describe processes leading to the existence of things.

Objective
The students should become familiar with some conceptual possibilities to recognise and deal with structures across the usual division of subjects. The problem areas are discussed on the basis of texts of various mathematicians and philosophers, with a wide range of applications such as psychology and life sciences.

851-0144-07L

The Infinite in Philosophy and in the Exact Sciences: Logic, Mathematics, Physics

Abstract

Objective
The students should become familiar with some conceptual possibilities to recognise and deal with structures across the usual division of subjects. The problem areas are discussed on the basis of texts of various mathematicians and philosophers, with a wide range of applications such as psychology and life sciences.
On the one hand, the topic of the infinite will be dealt with historically by discussing philosophical texts, by e.g., Kant, Bolzano and Cantor. On the other hand, the topic will be treated from a (non-historical) scientific point of view: the point of view of logic, mathematics, and physics.

To get acquainted with different types of infinity; to study what is intriguing or problematic about the infinite; to inquire whether these different types of infinity have (important) features in common.

**853-0060-00L** Current Issues in Security Policy

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<tr>
<td>3 credits</td>
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<td>2V</td>
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<tr>
<td>A. Wenger, O. Thränert</td>
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</table>

- **Abstract**: This course provides an overview of the development of the international system and the central security challenges since the end of the Cold War. The focus of this course will be on security issues of the post 9/11 era: new risks, arcs of crises, security strategies and core actors will be presented during the course.

- **Objective**: Students should gain a solid understanding of current issues in international security policy as well as of the central academic debates.

- **Content**: The aim of the course is to provide the participants with an overview of international security politics in a globalized world. After dealing with the major changes of the international security environment as compared to the cold war era, we will concentrate on some of the key challenges (international terrorism, proliferation of weapons of mass destruction etc.). The third part of the lecture focuses on security strategies pursued by the 'Western' world.

- **Lecture notes**: A reading list will be distributed at the beginning of the spring semester.

- **Prerequisites / notice**: An online learning platform serves as a supplement to the lecture course.

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**851-0101-47L** Science in the Twentieth Century: A Global Perspective WEBCLASS

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<tr>
<td>3 credits</td>
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<tr>
<td>2S</td>
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<tr>
<td>V. Bharadwaj, B. Schär</td>
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</table>

- **Abstract**: This course studies the 20th century history of those forms of knowledge framed specifically as science and technology, from a global perspective. It explores how exchanges and relationships between different parts of the world contributed to what is understood as science and "development". In doing so, it considers how the concept of science is entangled with structures of power and domination.

- **Objective**: - to critically consider the concepts and knowledge
  - to understand how advances in technology and science are historically rooted in European imperial expansion and are connected to global social inequalities in the postcolonial world.
  - to understand the historical plurality of forms of knowledge in different parts of the world as well as entanglements between different forms of knowledge
  - to systematically reconstruct and reproduce complex arguments (reading-competences)
  - to understand, compare and analyse differing approaches to the history of science.
  - to enable students to form an educated opinion and participate in discussions on the global history of science and knowledge

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**D-MATL**

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0125-41L</td>
<td>Introduction Into Philosophy of Technology</td>
<td>3 credits</td>
<td>2V</td>
<td>O. Müller</td>
</tr>
<tr>
<td>851-0549-00L</td>
<td>WebClass Introductory Course History of Technology</td>
<td>3 credits</td>
<td>2V</td>
<td>D. Gugerli</td>
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</tbody>
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**853-0060-00L** Current Issues in Security Policy

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- **Objective**: Students should gain a solid understanding of current issues in international security policy as well as of the central academic debates.

- **Content**: The aim of the course is to provide the participants with an overview of international security politics in a globalized world. After dealing with the major changes of the international security environment as compared to the cold war era, we will concentrate on some of the key challenges (international terrorism, proliferation of weapons of mass destruction etc.). The third part of the lecture focuses on security strategies pursued by the 'Western' world.

- **Lecture notes**: A reading list will be distributed at the beginning of the spring semester.
Dürfen Embryonen unter dem Aspekt selektiert werden, ob sie als Rettungsgeschwister geeignet sind, deren Zellgewebe einem schon
Man and Machine
2G
3 credits
L. Wingert
A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.
3 credits
Central Questions in Bioethics
2S
3 credits
L. Bharadwaj, B. Schär
This course studies the 20th century history of those forms of knowledge framed specifically as science and technology, from a global perspective. It explores how exchanges and relationships between different parts of the world contributed to what is understood as science and "development". In doing so, it considers how the concept of science is entangled with structures of power and domination.
Objective
- to critically consider the concepts of science and knowledge
- to understand how advances in technology and science are historically rooted in European imperial expansion and are connected to global social inequalities in the postcolonial world.
- to understand the historical plurality of forms of knowledge in different parts of the world as well as entanglements between different forms of knowledge
- to systematically reconstruct and reproduce complex arguments (reading-competences)
- to understand, compare and analyse differing approaches to the history of science.
- to enable students to form an educated opinion and participate in discussions on the global history of science and knowledge
851-0125-51L
Man and Machine
W 3 credits 2G M. Hampe, D. A. Strassberg
Particularly suitable for students of D-CHAB, D-HEST, D-MAVT, D-MATL
Abstract
The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different modells of machines will be important here: the clockwork, the steam engine and the computer.
Objective
On the one hand models of machines had a heursitcal value in research on man, e.g. in Harvey’s discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these modells were always criticised, sometimes polemically, because they are supposedly not adequate for man.
Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.
851-0125-52L
Central Questions in Bioethics
W 3 credits 2S L. Wingert
Particularly suitable for students of D-BIOL, D-CHAB, D-HEST, D-MAVT, D-MATL
Abstract
Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like "Protect the dignity of the living being"; or "Respect a person's self-determination"? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account.
Objective
dürfen Embryonen unter dem Aspekt selektiert werden, ob sie als Rettungsgeschwister geeignet sind, deren Zellgewebe einem schon geborenen anderen Kind durch Implantation das Leben retten kann? Soll die Forschung an Pillen erlaubt sein, die das menschliche Gedächtnis teilweise auslöschen und damit zum Beispiel traumatische Erlebnisse beseitigen können? Spricht wirklich mehr gegen die Tiefenchemie oder für die Biotechnik? Der Kurs hat das Ziel, einige der wichtigsten bioethischen Fragen zu erforschen.
Es sollen normative Prinzipien identifiziert werden, die oft faktisch bioethischen Entscheidungen zu Grunde liegen. Und es sollen überzeugende Prinzipien ermittelt werden.
Zugleich sollen die Teilnehmer Kenntnisse erwerben über die Entwicklungen in zeitgenössischen Gesellschaften westlichen Typs (mit individuellen Grundrechten, kapitalistischer Marktwirtschaft und systematische wissenschaftlicher Forschung, die mit der Dynamik von Biotechniken zusammenhängen).
Literature
1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.
851-0144-01L
Introduction to the Philosophy of Physics
W 3 credits 2S N. Sieroka
Particularly suitable for students of D-MAVT, D-MATL
Abstract
This is an introductory course in different areas and positions in the philosophy of physics. It falls into different parts, including one on the concepts of space and time and one on the reality of structures in physics.
Objective
Students should be able to name and critically evaluate different topics and approaches and in the philosophy of physics.
851-0306-05L
Literature and Technology - Simulations, Prototypes, Machines
W 3 credits 2S N. Sieroka
Particularly suitable for students of D-ITET, D-MAVT, D-MATL
Abstract
Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of technological configurations of knowledge.
Objective
Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.
Content
Im Seminar lesen wir unter anderem Texte von E.T.A. Hoffmann, Franz Kafka, Georg Kaiser und Max Frisch.
851-0549-12L
Sharing. The History of an Attractive Technology
W 3 credits 2S D. Gugerli
Particularly suitable for students of D-ARCH, D-BAUG, D-HEST, D-INFK, D-ITET, D-MAVT, D-MATL
Abstract
The seminar deals with hot topics of the history of technology since the 1960s. Sharing of computertime, software and data will be discussed as a crucial offer and problem of late modernity.
Objective
The course wants to develop the students ability to critically read and asses historic texts.
Lecture notes
A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.
851-0591-00L
Digital Sustainability in the Knowledge Society
W 2 credits 2V M. M. Dapp
Particularly suitable for students of D-INFK, D-ITET, D-MAVT, D-MATL

Ziel der Diskussion ist die Untersuchung der Wirtschaftlichkeit von Wissensumverteilung und der Entwicklung der Digitalisierung in der Gesellschaft. Die digitale Revolution ermöglicht neue Wege der Informationsverarbeitung und -verbreitung, die auch die Wissenschaftsforschung beeinflussen.

Literatur


Ziel der Diskussion ist die Untersuchung der Wirtschaftlichkeit von Wissensumverteilung und der Entwicklung der Digitalisierung in der Gesellschaft. Die digitale Revolution ermöglicht neue Wege der Informationsverarbeitung und -verbreitung, die auch die Wissenschaftsforschung beeinflussen.
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle environmental and science communication, becoming more sensitive for environmental and science communication. They will be illustrated by concrete examples and via lectures from external guests. I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended.

| Literature |
| Required reading: |
| Perman et al. (2003), Natural Resource and Environmental Economics, Pearson Addison Wesley. |
| Also, Journal articles will be cited |

| Prerequisites / notice |

| 851-0703-00L Introduction to Law |
| W | 2 credits | 2V | O. Streifgnöpff |
| Students who have attended or will attend the lecture "Introduction to Law for Civil Engineering and Architecture" or "Introduction to Law" (851-0708-00), cannot register for this course unit. |

| Abstract |
| This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered. |

| Objective |
| Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes. |

| Content |
| Basic concepts of law, sources of law. |
| Private law: Contract law (particularly contract for work and services), tort law, property law. |
| Public law: Human rights, administrative law, procurement law, procedural law. |
| Insights into the law of the EU and into criminal law. |

| Lecture notes |
| Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library) |

| Literature |
| Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=1596). |

| 851-0738-00L Intellectual Property: Introduction |
| W | 2 credits | 2V | M. Schweizer |
| Particularly suitable for students of D-MAVT, D-MATL |

| Abstract |
| The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases. |

| Objective |
| The aim of this course is to enable students at ETH Zürich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases. |

| Content |
| Introduction to general and applied ethics. |
| Overview and discussion of ethical theories relevant to the environment. |
| Familiarisation with various basic standpoints within environmental ethics. |
| Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc. |
| Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.) |

| Lecture notes |
| Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list. |
| In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, Zürich 2010 (to be published Autumn 2010). |

| Literature |
| Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003 |
| John O’Neill et al., Environmental Values, 2006 |
| Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008 |
| General introductions: |
| Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, Zürich 2014, 2. Auflage |
| Marcus Düwell et. al (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006 |
| Johann S. Ack et. al. (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008 |

| Prerequisites / notice |
| The procedure for accumulating CP will be explained at the start of term. I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively. |

| 701-0703-00L Environmental Ethics |
| W | 2 credits | 2V | M. Huppenbauer |

| Abstract |
| The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle environmental and science communication. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies. |

| Objective |
| On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies. |

| Content |
| - Introduction to general and applied ethics. |
| - Overview and discussion of ethical theories relevant to the environment. |
| - Familiarisation with various basic standpoints within environmental ethics. |
| - Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc. |
| - Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.) |

| Lecture notes |
| Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list. |
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| Marcus Düwell et. al (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006 |
| Johann S. Ack et. al. (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008 |

Data: 06.12.2018 13:04 Autumn Semester 2015 Page 611 of 1432
Content

I. Introduction
- Topics: Environment, Science, Risks, Media
- Forms, Functions, Effects of Public and Mass Communication

II. Stakeholders and their Public Relations Efforts
- Public Relations and Science PR: Theoretical Perspectives, Instruments

III. Science and Environmental Issues in the Media
- Forms and Functions of Science Journalism
- Problems of Selection, Interpretation, Quality
- Media Content Analysis
- Online Communication

IV. Uses and Effects of Science and Environmental Communication
- Extent of Media Use
- Effects on Knowledge, Risk Perceptions, Environmental Attitudes
- Effects on Science itself

Lecture notes

Literature


Prerequisites / notice

Die Vorlesung wendet sich auch an Studierende der Publizistikwissenschaft der Universität Zürich

Voraussetzungen: Die Vorlesung hat einführenden Charakter.

701-0791-00L Environmental History - Introduction and Overview W 2 credits 2V D. Speich Chassé
Number of participants limited to 100.

Abstract
Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

Objective
Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems.

Lecture notes
Course material is provided on OLAT.

Literature

Prerequisites / notice

Students are asked to write an exam during the second last session (11.12.2015).

701-0985-00L Social Intercourse with Current Environmental Risks W 1 credit 1V B. Nowack, C. M. Som-Koller

Abstract
The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

Objective
- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)

Content
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- Prospects for future developments

Prerequisites / notice

The lecture is held biweekly (for 2 hours). The dates are 21.9., 28.9 (attention, out of schedule) ; 19.10, 2.11, 16.11, 30.11, 14.12

853-0047-01L World Politics Since 1945: The History of International Relations (Without Exercises) W 3 credits 2V A. Wenger


Abstract
This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

Objective
By the end of the semester, participants of the lecture should have a solid knowledge on the history and theoretical foundations of International Relations since the end of the Second World War.

Content
of "Diploma Supplement"

Literature
Compulsory Reading:


Prerequisites / notice
The lecture is being supported by a virtual classroom. If you have any questions, please contact Lukas Meyer, lukas.meyer@sipo.gess.ethz.ch.

D-MTEC

851-0101-46L
Introduction in the History of Economic Thought
Particularly suitable for students of D-MTEC.

Abstract
The course offers a historical introduction to modern economic thought. It looks at texts of 'classical economics' as well as 'neo-classical', 20th century texts. In addition, the course addresses some modern contributions in the history of economics - in particular extra-European economic history - and their potential for the enrichment of mainstream economic thought.

Objective
he course is conceptualized as an introduction to the history of economic thought. It acquaints students with the basic tenets of the 'classical economics' through historical accounts of the work of 'worldly philosophers' as well as by reading extracts of Adams Smith, David Ricardo and Karl Marx. Further, the course introduces students to 'neo-classical economics' of the 20th century, again looking at authors of particular significance in the furthenance of economic debates such as John Maynard Keynes, Milton Friedman and Friedrich Hayek. The course, however, also takes a closer look at authors whose work is usually situated beyond conventional economic thought, such as Karl Polanyi. Additionally, the course devotes also time to some extra-European economic thought - drama theory, world system and dependency theory, etc. - and its implications/applications in the history of the 20th century. Finally, a particular attention will be paid to some important contributions in the extra-European history of economics and to specific notions such as 'commodity chains', 'divergences' and 'modernization'. Combining these various items, the course aims not simply at introducing students to the 'evolution' of economic thought, but much more broadly to ongoing academic debates, political and ideological tensions as well as to critical reflections. The ambition of the course is to inspire through a historical approach and to enrich the 'understanding' of economic theory with a questioning of its underlying structures and tenets and, ultimately, to advance critical thinking among students of modern economics.

851-0591-00L
Digital Sustainability in the Knowledge Society
Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC. D-USYS

Abstract
How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g., Open Source/Content/Access. The course discusses consequences from different angles and introduces digital sustainability as an alternative vision for society.

Objective
At the heart of the course is the handling of digital goods and intellectual property in society. Digitalization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you (hopefully) be able to

- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

Content
Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of "intellectual property", which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and use of digital knowledge.

Comparing the situation to the environment of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «lesser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.digisius.info starting from September. Stay tuned.

Lecture notes
Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Prerequisites / notice
For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the participants is limited to 45.

851-0157-56L Avantgarde-Life: Utopia of the ‘New Man’ Between Science and Technology W 3 credits 2S M. Wulz

The seminar is fully booked!

Abstract
At the beginning of the 20th century, the artistic and social avantgarde movements developed visions of a 'New Man' with new modes of perception and within new forms of social life. The seminar deals with the scientific, technological, artistic, pedagogical, and political designs for a new living.

Objective
The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It focuses on the correlation of the contemporary scientific and technological developments and the conceptions of a 'New Man'. The discipline of psychotechnics together with scientific and technological designs of living and working environments formulated visions of new and enhanced ways of human living and perception. In the seminar, we will examine the utopian visions of life in the avantgarde movements. Touching upon the fields of the life sciences, economics, management, progressive education, architecture, and art we will reflect the diverse relations between science, technology, and human living.

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB W 3 credits 2S D. Helbing, S. Bailletti, O. Woolley

Content
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g., models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Prerequisites
The number of participants is limited to 70.

851-0585-41L From Computational Social Science to Global Systems Science W 3 credits 2S D. Helbing

Abstract
The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work, (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work.

Objective
Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

363-1065-00L Design Thinking: Human-Centred Solutions to Real World Challenges W 5 credits 5G A. Cabello Llamas, S. Brusoni, C. Hölscher, M. Meboldt, F. Rittiner

All interested students are invited to apply for this course by sending a one-page motivation letter until 07.09.2015 to Florian Rittiner (frittiner@ethz.ch).

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

Abstract
The purpose of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in multidisciplinary teams to solve a set of design challenges that are organized as a one-week, a three-week, and a six-week project. The final project will be in collaboration with an external project partner.

Objective
During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

363-1050-00L Conference of Disarmament: Simulation of Negotiations W 3 credits 2S M. Ambühl

Abstract
The Global Studies Institute (University of Geneva) is organizing a simulation seminar on nuclear disarmament in collaboration with the Chair of Negotiation and Conflict Management (ETH), experts from the United Nations Institute for Disarmament Research and the Geneva Center for Security Policy.
The simulation project is intended for Master's or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Geneva Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations), of keeper of the minutes or of observers and analysts.

Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the "Capitals" to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

<table>
<thead>
<tr>
<th>Dates/Time/Location (GE = University of Geneva)</th>
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<tbody>
<tr>
<td>22 Sept.</td>
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<tr>
<td>29 Sept.</td>
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<td>6 Oct.</td>
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<td>13 Oct.</td>
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<td>20 Oct.</td>
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<td>27 Oct.</td>
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<td>10 Nov.</td>
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<td>17 Nov.</td>
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<td>26 &amp; 27 Nov.</td>
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<td>1 Dec.</td>
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Note: The participation in the simulation on 26. and 27. November in Geneva is necessary. The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation in Geneva, attend the 3 mandatory lecture parts via conference call an Zurich and write a report of 5 pages at the end of the course.

Technical note for registration: At this stage all registered students are on the waiting list.

860-0006-00L | Statistical Data Analysis | W | 3 credits | 3G | M. Höglinger, I. Günther, K. Harttgen

Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference.

Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

Objective
Students will have the possibility to participate in simulated diplomatic negotiations and to analyse and assess the negotiation logic behind the situations. They should gain insight in the basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general.

Content
The simulation project is intended for Master's or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Geneva Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations), of keeper of the minutes or of observers and analysts.

Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the "Capitals" to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 615 of 1432

D-MAVT

851-0125-51L | Man and Machines | W | 3 credits | 2G | M. Hampe, D. A. Strassberg

Abstract
The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.

Objective
On the one hand models of machines had a heuristic value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these models were always criticised, sometimes polemically, because they are supposedly not adequate for man.

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

851-0306-05L | Literature and Technology - Simulations, Prototypes, Machines | W | 3 credits | 2S

Particularly suitable for students of D-ITET, D-MAVT, D-MATL

Note: The participation in the simulation on 26. and 27. November in Geneva is necessary. The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation in Geneva, attend the 3 mandatory lecture parts via conference call an Zurich and write a report of 5 pages at the end of the course.

Technical note for registration: At this stage all registered students are on the waiting list.
### The Role of Intellectual Property in Daily Routine: A Practical Introduction

**Abstract**

The lecture gives engineering students an overview of the basic aspects of intellectual property. The lecture aims at making participants aware of various methods of protection and to put them in a position to be able to use this knowledge in the workplace.

**Objective**

In recent years, knowledge about intellectual property has become increasingly important for engineers. In both production and distribution as well as in research and development, engineers are increasingly being confronted with questions concerning the patenting of inventions and the utilisation of patent information. With up to 80% of publicly-available technical information being stored in patents only, it is of great importance for engineers to know the basics of the patent system and to be in a position to be able to extract relevant information from the flood of patent information available. This relates to daily work in industry as well as in research, where protecting inventions has gained in importance.

Patents are also an important source of information - from competitors and potential cooperation partners to the development of markets and the risk of coming into conflict with third party IP rights. Respectively, a knowledge of patents has also become a key qualification at a company's strategic level.

The seminar is customised to the needs of engineers. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.

The seminar contains practical exercises on the use and research of patent information. Basic knowledge on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

**Prerequisites / notice**

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture 'Protecting inventions in chemistry' will be offered, which is coordinated to the needs of students in these degree programs.

### Introduction Into Philosophy of Technology

**Abstract**

Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to a autonomous philosophy of technology, which had become important also for other philosophical disciplines (e.g. in Heidegger's philosophy).

**Objective**

The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protocol is to be written.

**Prerequisites**

The lecture is particularly suitable for students of D-ARCH, D-BAUG, D-HEST, D-INFK, D-ITET, D-MAVT, D-MATL.

### Sharing, The History of an Attractive Technology

**Abstract**

The seminar deals with hot topics of the history of technology since the 1960s. Sharing of computertime, software and data will be discussed as a crucial offer and problem of late modernity.

**Objective**

The course wants to develop the students ability to critically read and assess historic texts.

**Lecture notes**

A detailed program and course materials will be made available during the semester on [www.tg.ethz.ch](https://www.tg.ethz.ch).

### WebClass Introductory Course History of Technology

**Abstract**


**Prerequisites / notice**


Die Zahl der Teilnehmenden ist auf 100 beschränkt. Anmeldung: In der Einführungssitzung am 21.9.2015, zudem schriftliche Verspätete Anmeldungen können nicht berücksichtigt werden.

### WebClass Introductory Course History of Technology

**Abstract**


**Prerequisites / notice**


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Weitere Informationen unter [https://www.tg.ethz.ch/de/programme/](https://www.tg.ethz.ch/de/programme/).
851-0585-41L From Computational Social Science to Global Systems Science

**Objective**

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work. (2) combining perspectives of different scientific disciplines (e.g., sociology, computer science, physics, complexity science, engineering). (3) bridging between fundamental and applied work.

**Objective**

Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e., an interdisciplinary integration of knowledge.

---

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB

**Content**

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g., models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

**Literature**

2. MATLAB kompakt, Wolfgang Schweizer, (Oldenburg, 2006)

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

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851-0125-52L Central Questions in Bioethics

**Objective**


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851-0144-01L Introduction to the Philosophy of Physics

**Objective**

Students should be able to name and critically evaluate different topics and approaches in the philosophy of physics.

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851-0591-00L Digital Sustainability in the Knowledge Society

**Objective**

Digital Sustainability in the Knowledge Society

Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MATEC, D-USYS

**Literature**

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling
in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it.
Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is
transferred to digital goods, taking into account the particular nature of digital stuff.
After the lecture, you should (hopefully) be able to
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitalization plus Internet» allows for the first time in humankind's history the (theoretically) free and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»
The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.
Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hardware and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.
Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with GNU/Linux as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...
As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

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<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended</th>
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<tbody>
<tr>
<td>851-0703-00L Introduction to Law</td>
<td>2 credits 2V O. Streiff Gnöpff</td>
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<tr>
<td>Students who have attended or will attend the lecture &quot;Introduction to Law for Civil Engineering and Architecture&quot; or &quot;Introduction to Law&quot; (851-0708-00) cannot register for this course unit.</td>
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</tr>
<tr>
<td>Particularly suitable for students of D-MAVT, D-MATL</td>
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</tr>
<tr>
<td>Abstract</td>
<td>This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.</td>
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<tr>
<td>Objective</td>
<td>Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.</td>
</tr>
<tr>
<td>Content</td>
<td>Basic concepts of law, sources of law. Private law: Contract law (particularly contract for work and services), tort law, property law. Public law: Human rights, administrative law, procurement law, procedural law. Insight into the law of the EU and into civil law.</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library)</td>
</tr>
<tr>
<td>Literature</td>
<td>Further documents will be available online (see <a href="https://moodle-app2.let.ethz.ch/course/view.php?id=1596">https://moodle-app2.let.ethz.ch/course/view.php?id=1596</a>).</td>
</tr>
<tr>
<td>851-0738-00L Intellectual Property: Introduction</td>
<td>2 credits 2V M. Schweizer</td>
</tr>
<tr>
<td>Particularly suitable for students of D-ITET, D-MAVT, D-MATL</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.</td>
</tr>
<tr>
<td>Objective</td>
<td>The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.</td>
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<tr>
<td>Further another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).</td>
<td></td>
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<tr>
<td>Literature</td>
<td>M. Schweizer</td>
</tr>
<tr>
<td>701-0703-00L Environmental Ethics</td>
<td>2 credits 2V M. Huppenbauer</td>
</tr>
<tr>
<td>The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.</td>
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<tr>
<td>Objective</td>
<td>On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognizing and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies.</td>
</tr>
<tr>
<td>Content</td>
<td>- Introduction to general and applied ethics. - Overview and discussion of ethical theories relevant to the environment. - Familiarisation with various basic standpoints within environmental ethics. - Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc. - Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>- Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, Zürich 2010 (to be published Autumn 2010).</td>
</tr>
<tr>
<td>- John O’Neill et al., Environmental Values, 2008</td>
<td></td>
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<tr>
<td>- Klaus Peter Rippe, Ethisch im ausserhumanen Bereich, Paderborn (mentis) 2008</td>
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<tr>
<td>- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003</td>
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<tr>
<td>- Johann S. Ach et. al., Environmental Values, 2008</td>
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<tr>
<td>- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)</td>
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<tr>
<td>701-0785-00L Environmental and Science Communication</td>
<td>4 credits 2V M. Schäfer</td>
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<tr>
<td>The course gives an introductory overview in research questions, theoretical perspectives and empirical results of science communication and environmental communication. They will be illustrated by concrete examples and via lectures from external guests.</td>
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<tr>
<td>Objective</td>
<td>Goals: Learning to understand structures and processes of environmental and science communication, becoming more sensitive for problems of science public relations, getting an insight into public debates about environmental issues.</td>
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<tr>
<td>Methods: Case studies, invitation of media practitioners and experts, discussions, lectures on key theoretical concepts of communication.</td>
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<tr>
<td>Topics: Concrete communication instruments like media conferences, theoretical perspectives of public relations, basic principles and examples of information campaigns, environment and science as media topics, functions and structures of science communication, relations between science, media and politics.</td>
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</tr>
</tbody>
</table>
Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times, C. M. Som-Koller

Environmental History - Introduction and Overview

Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

I. Introduction
- Topics: Environment, Science, Risks, Media
- Forms, Functions, Effects of Public and Mass Communication

II. Stakeholders and their Public Relations Efforts
- Public Relations and Science PR: Theoretical Perspectives, Instruments

III. Science and Environmental Issues in the Media
- Forms and Functions of Science Journalism
- Problems of Selection, Interpretation, Quality
- Media Content Analysis
- Online Communication

IV. Uses and Effects of Science and Environmental Communication
- Extent of Media Use
- Effects on Knowledge, Risk Perceptions, Environmental Attitudes
- Effects on Science itself

Literature


Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.


III. Science and Environmental Issues in the Media

Objective
Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one’s own standpoint.

Lecture notes
Course material is provided on OLAT.

Literature
Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.


Prerequisites / notice
Die Vorlesung wendet sich auch an Studierende der Publizistikwissenschaft der Universität Zürich

Voraussetzungen: Die Vorlesung hat einführenden Charakter.

701-0791-00L Environmental History - Introduction and Overview W 2 credits 2V D. Speich Chassé

Abstract
Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

Objective
Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one’s own standpoint.

Lecture notes
Course material is provided on OLAT.

Literature
Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.


Prerequisites / notice
Students are asked to write an exam during the second last session (11.12.2015).

701-0985-00L Social Intercourse with Current Environmental Risks W 1 credit 1V B. Nowack, C. M. Som-Koller

Abstract
The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

Objective
- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)
- Knowledge about possibilities for sustainable innovation

Content
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- prospects for future developments

Lecture notes
Copies of slides and selected documents will be distributed

Prerequisites / notice
The lecture is held biweekly (for 2 hours). The dates are 21.9., 28.9 (attention, out of schedule); 19.10, 2.11, 16.11, 30.11, 14.12

853-0047-01L World Politics Since 1945: The History of International Relations (Without Exercises) W 3 credits 2V A. Wenger

Number of participants limited to 100.

Autumn Semester 2015
This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

By the end of the semester, participants of the lecture should have a solid knowledge on the history and theoretical foundations of International Relations since the end of the Second World War.

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

The lecture is being supported by a virtual classroom. If you have any questions, please contact Lukas Meyer, lukas.meyer@sipo.gess.ethz.ch.

### D-PHYS

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0144-07L</td>
<td>The Infinite in Philosophy and in the Exact Sciences: Logic, Mathematics, Physics</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>G. Sommeruga</td>
</tr>
<tr>
<td>851-0585-41L</td>
<td>From Computational Social Science to Global Systems Science</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>D. Helbing</td>
</tr>
<tr>
<td>851-0585-04L</td>
<td>Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>D. Helbing, S. Ballei, O. Woolley</td>
</tr>
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### D-USYS

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<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>851-0300-93L</td>
<td>Philosophy of Biology</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Schwarz</td>
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The philosophy of biology deals with concepts and problems that occur specifically while dealing with living entities. Accordingly, it covers the historical as well as systematic aspects of concepts like gene or species, or theories explaining diversity or stability, competitive or cooperative action. Another important topic is the role of technology while affording biological objects.

The overarching objective of this seminar is to get an impression of the specificity of biological problems and to develop an appropriate philosophical sensibility. Accordingly, philosophical traditions in biology will be discussed, just as the application of the history of science in the context of biology. The seminar reader will consist of contributions of biologists as well as philosophers of biology. Besides the basic concepts in biology such as gene, species, evolution, or diversity, we will also be reflecting on the relationship between technology, experimenting, and biological objects. Depending on the interests of the seminar participants, the examples to be discussed may be chosen from systems biology, molecular or synthetic biology, ecology or else.

851-0591-00L Digital Sustainability in the Knowledge Society
Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g., Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way which fundamentally contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to:
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- giving an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software movement to other digital goods (e.g., open content, open access)

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. "Digitization plus Internet" allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparable to the environmentalist movement of the 60's and 70's, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

As an «ethnography» of digital sustainability, you are offered the following assignments: (a) choose a cultural or scientific example of digital sustainability and explain and argue its relevance for the knowledge society;
(b) present the historical and legal context of the example;
(c) research on the conditions under which cooperation in digital sustainability has emerged and the conditions under which cooperation will fail;
(d) reflect on the model of digital sustainability and place it into the context of «digital sustainability» as a whole concept
(e) explore and test different offers of digital resources and their production; (f) research on the conditions under which cooperation in digital sustainability has emerged and the conditions under which cooperation will fail;
(g) reflect on the model of digital sustainability and place it into the context of «digital sustainability» as a whole concept
(h) explore and test different offers of digital resources and their production;

Didactic objectives: Students are invited to explore and experience the conditions under which cooperation in digital sustainability has emerged and the conditions under which cooperation will fail. In addition, they are asked to reflect on the model of digital sustainability and place it into the context of «digital sustainability» as a whole concept (a systemic approach).

Content of the following books is covered (PDFs freely available online):
4. Other recommended books are:
   (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

Prerequisites / notice
For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the exchange of knowledge and experiences.

851-0594-00L International Environmental Politics
Particularly suitable for students of D-ITET, D-USYS

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

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

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

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

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

Lecture notes
Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your Netzh username and password to access the material.

Literature
See www.ib.ethz.ch (teaching, materials)
Prerequisites / notice
Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of the semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The workload for this course is approx. 120 hours (all inclusive).

851-0609-05L The Economics of Climate Change W 3 credits 2V
Particularly suitable for students of D-ITET, D-MATL, D-MAT, D-USYS
Abstract
Climate change is one of the most pressing issues that governments and the global community have to face. This course outlines the problem of climate change and discusses the economic solutions (both domestic and international) to this problem.
Objective
This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic solutions to combating climate change (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.
Content
Economics of pollution, Optimal level of greenhouse gases, International Environmental Agreements, Tradable pollution permit markets, Carbon Taxes, Technological innovation and R&D, The optimal approach to control Climate Change, The future of Climate change policy
Literature
Required reading:
Perrman et al. (2003), Natural Resource and Environmental Economics, Pearson Addison Wesley.
Also, Journal articles will be cited
Prerequisites / notice
Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended

851-0705-02L Environmental Law: Topics and Case Studies W 2 credits 2S C. Jäger
Number of participants limited to 20.
Prerequisites: Environmental Law: Conceptions and Fields ((851-0705-01L) offered in spring semester.
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS
Abstract
This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.
Objective
The aim of this workshop is to equip students with legal skills and methods to solve or treat problems and questions of the environmental law and foster understanding on the possibilities and limits of legal problem-solving. The students choose an inquiry with practical relevance. To this end they work out the legal basis demonstrating a legal correct solution or approach to a solution. In doing so, students will get to know legal methods and research possibilities.
Content
At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.
Lecture notes
Den Studierenden werden Unterlagen zur juristischen Metoden- und Quellenlehre sowie zum Inhalt und Ablauf des Kurses zu Beginn der Veranstaltung kostenlos abgegeben.
Literature
Rechtsgrundlagen, Literatur und Gerichtsentscheide werden themenspezifisch selber rechechiert, unter Mithilfe und Beratung des Dozenten.
Prerequisites / notice
Die Veranstaltung erfordert die Bereitschaft, sich aktiv und selbständig mit einer selbstgewählten Fragestellung oder einem eigenen Fallschreiben aus dem Gebiet des Umweltrechts auseinanderzusetzen. Damit die Interaktivität und die Begleitung der Teams gewährleistet werden kann, ist die Teilnehmerzahl auf maximal 16 Personen beschränkt. Es handelt sich um eine Vertiefungsveranstaltung. Der Besuch der Vorlesung "Umweltrecht: Konzepte und Rechtsgebiete" (851-0705-01) ist Voraussetzung.

851-0707-00L Space Planning Law and Environment W 2 credits 2G O. Bucher
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS
Abstract
System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.
Objective
Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.
Content
Lecture notes
Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999
Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 5.A., Bern 2008

851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law W 2 credits 2V M. Huser
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS
Abstract
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance. 

Politics of Environmental Problem Solving in Developing Countries

The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries’ realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions.
### Content

Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement. From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

### Lecture notes

Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle).

### Literature

- Keel/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/2
- Rausch, H.; Panorama des Umweltrechts - Kompendium der Umweltschutzvorschriften des Bundes, BUWAL-Schriftenreihe Umwelt Nr. 226, 4. A., Bern 2005
- Rausch, H.; Panorama des Umweltrechts - Kompendium der Umweltschutzvorschriften des Bundes, BUWAL-Schriftenreihe Umwelt Nr. 226, 4. A., Bern 2005

### Prerequisites / notice

The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

### 701-0743-01L

**Lecture notes**

Den Studierenden werden Unterlagen wie eine Übersicht über den behandelten Stoff auf PP-Folien, typische Gerichtsentscheide, Materialien etc. über neue Vorhaben mit Auswirkungen auf die Umwelt und entsprechenden Rechtsfragen abgegeben.

**Literature**

Griffel, A.; Raumplanungs- und Baurecht in a nutshell, Dike Verlag, Zürich/St. Gallen 2012
- Rausch/Marti/Griffel: Umweltrecht - Ein Lehrbuch, Herausgeber: Walter Haller, Schuffner Verlag, Zürich 2004
- Rauch, H.; Panorama des Umweltrechts - Kompendium der Umweltschutzvorschriften des Bundes, BUWAL-Schriftenreihe Umwelt Nr. 226, 4. A., Bern 2005
- Keel/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3
- Rausch, H.; Panorama des Umweltrechts - Kompendium der Umweltschutzvorschriften des Bundes, BUWAL-Schriftenreihe Umwelt Nr. 226, 4. A., Bern 2005

**Prerequisites / notice**

Die Veranstaltung ist eine vorwiegend mit konkreten Beispielen arbeitende und auf natürliche Ressourcen, Landschaften und Raumordnung fokussierte Vertiefung. Die Studierenden können eigene "Fälle" aus dem persönlichen Umfeld einbringen. Der Kurs bietet eine Vertiefung in folgende Rechtsgebiete:
- Waldrecht - Natur- und Landschaftsschutzrecht - Wasserrecht - Raumanplanungsrecht - Umweltschutzrecht - Verfahrensrecht
- Unterschriftsprache: Deutsch

### 701-0703-00L

**Environmental Ethics**

The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

**Objective**

On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems.

**Content**

- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

**Lecture notes**

Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, Zürich 2010 (to be published Autumn 2010).
The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on society. This introductory class in environmental sociology covers different theoretical approaches but the main focus is on recent empirical research on topics such as environmental behavior, environmental concern, social dilemmas, social norms, environmental justice, and risk perception.

**Goals:** Learning to understand structures and processes of environmental and science communication, becoming more sensitive for the relations between science, media and politics.

**Methods:** Case studies, invitation of media practitioners and experts, discussions, lectures on key theoretical concepts of communication.

**Contents:**
- Topics: Environment, Science, Risks, Media
- Forms, Functions, Effects of Public and Mass Communication
- Stakeholders and their Public Relations Efforts
- Public Relations and Science PR: Theoretical Perspectives, Instruments
- Science and Environmental Issues in the Media
- Forms and Functions of Science Journalism
- Problems of Selection, Interpretation, Quality
- Media Content Analysis
- Online Communication

**Uses and Effects of Science and Environmental Communication**
- Effects on Science itself
- Effects on Knowledge, Risk Perceptions, Environmental Attitudes
- Extent of Media Use
- Problems of Selection, Interpretation, Quality
- Media Content Analysis
- Online Communication

**Prerequisites / notice**

I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

**Literature**


**Language**

E. Lieberherr


M. Schäfer

The course gives an introductory overview in research questions, theoretical perspectives and empirical results of science communication and environmental communication. They will be illustrated by concrete examples and via lectures from external guests.

**Goals:** Learning to understand structures and processes of environmental and science communication, becoming more sensitive for problems of science public relations, getting an insight into public debates about environmental issues.

**Methods:** Case studies, invitation of media practitioners and experts, discussions, lectures on key theoretical concepts of communication.

**Topics:** Concrete communication instruments like media conferences, theoretical perspectives of public relations, basic principles and examples of information campaigns, environment and science as media topics, functions and structures of science communication, relations between science, media and politics.

**Contents**

I. Introduction
- Topics: Environment, Science, Risks, Media
- Forms, Functions, Effects of Public and Mass Communication

II. Stakeholders and their Public Relations Efforts
- Public Relations and Science PR: Theoretical Perspectives, Instruments

III. Science and Environmental Issues in the Media
- Forms and Functions of Science Journalism
- Problems of Selection, Interpretation, Quality
- Media Content Analysis
- Online Communication

IV. Uses and Effects of Science and Environmental Communication
- Effects on Science itself
- Effects on Knowledge, Risk Perceptions, Environmental Attitudes
- Effects on Media Use

**Prerequisites / notice**

The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

**Literature**


**Language**

E. Lieberherr


M. Schäfer

The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on society. This introductory class in environmental sociology covers different theoretical approaches but the main focus is on recent empirical research on topics such as environmental behavior, environmental concern, social dilemmas, social norms, environmental justice, and risk perception.

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- Effects on Knowledge, Risk Perceptions, Environmental Attitudes
- Effects on Media Use

**Prerequisites / notice**

The detailed semester program (syllabus) is made available to the students at the beginning of the semester.
The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies. Students are able to critically interpret results of a regression model, in particular, regarding causal inference. They are able to formulate and implement a regression model for a particular research question and a particular type of data. They know strategies to test causal hypotheses using regression analysis with experimental and quasi-experimental methods. They know some basics about regression models for multinomial, ordered, or censored response variables, as well as for count data. Students have a sound understanding of linear and logit regression. They are able to formulate and implement a regression model for a particular research question and a particular type of data. They are able to critically interpret results of a regression model, in particular, regarding causal inference.
The main objective of this course is to practice and improve the four language skills of participants (listening, speaking, reading and writing). The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

### Language Courses ETH/UZH

*Please be advised that your online-registration at the language centre has to be simultaneous ([www.sprachenzentrum.uzh.ch](http://www.sprachenzentrum.uzh.ch)) as otherwise your registration for the course will not be valid.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0816-07L</td>
<td>French: Literature (B2-C1) ■</td>
<td>W</td>
<td>2 credits</td>
<td>1U</td>
<td>J.P. Coen</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course focuses on modern and contemporary literary texts.</td>
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<tr>
<td>Objective</td>
<td>The course will help students to improve their French, whilst developing greater discrimination in reading. It will also offer them the opportunity to increase their awareness of different literary genres and contemporary cultural issues.</td>
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</tr>
<tr>
<td>851-0816-08L</td>
<td>French: Advanced (B2-C1) ■</td>
<td>W</td>
<td>1 credit</td>
<td>1U</td>
<td>J.P. Coen</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is intended for students who have reached level B2. Participants will train their skills so that they may perform clear, fluent and well structured contributions during general debates.</td>
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<tr>
<td>Objective</td>
<td>The main emphasis is on spoken skills, with the aim of enabling students to develop their own voice in expressing their views and developing arguments efficiently. The course also nurtures the ability to understand detailed and implicit meaning in documents concerning aspects of society at large.</td>
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</tr>
<tr>
<td>851-0816-13L</td>
<td>Practising French in Context ■</td>
<td>W</td>
<td>1 credit</td>
<td>1G</td>
<td>J.P. Coen</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course targets B2/C1 French learners. It is not open to French native speakers.</td>
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<tr>
<td>Objective</td>
<td>The main objective of this course is to practice and improve the four language skills of participants (listening, speaking, reading and writing). Students will have to make a presentation in French on a complex subject, interact in a group, defend a point of view and answer to objections.</td>
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<tr>
<td>851-0816-15L</td>
<td>French: Advanced (B2) ■</td>
<td>W</td>
<td>1 credit</td>
<td>1U</td>
<td>A.F. Betz</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is intended for students who have reached level B2. Participants will train their skills so that they may perform simple contributions during general debates.</td>
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<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The main emphasis is on spoken skills, with the aim of enabling students to develop their own voice in expressing their views and developing arguments efficiently. The course also nurtures the ability to understand a general meaning in documents concerning aspects of society at large.</td>
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<tr>
<td>851-0823-00L</td>
<td>English Language and Literature Part I (C1-C2) ■</td>
<td>W</td>
<td>2 credits</td>
<td>2U</td>
<td>M. Norgate</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course for Bachelor and Master students at C1-C2 level is designed to enhance students' perception and understanding of literature written in English. Through the analysis and interpretation of literary texts, students will improve their own textual analysis and language skills.</td>
<td></td>
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</tr>
</tbody>
</table>
| Objective | The aims of the course are to:  
* Introduce students to the traditions and conventions of literature written in English  
* Help students to develop critical, creative, and personal approaches to analyzing literary works  
* Provide students with an opportunity to enhance and practice their argumentation skills in discussions and writing  
* Improve they ways in which students organize their ideas and arguments in a sustained, coherent, and logical manner  
* Improve students grammatical and lexical repertoire through reading and discussion  
* Impart a life-long interest in a wide and diverse range of literature written in English |
| Content | A variety of texts, such as classic and modern poetry, short fiction, and one short novel, will be explored. Classwork will be interactive, with pair, small group, and plenary discussions, giving all class members the chance to practice speaking freely and sustaining an argumentative line of discourse. Writing tasks will be assigned to produce coherent and well-structured texts. Lexical work will help students to increase their range of vocabulary and allow them to apply freshly acquired vocabulary in speaking and writing. |
| Lecture notes | no script. |
| Literature | Materials: Texts will be made available either online (OLAT) or as handouts. |

The course covers: a review of vocabulary building and extension, including the Academic Word List and formulaic language; input on.

The course gives a chronological view of New Zealand's literary heritage from Maori settlement to the present day, using selected poems, a

The course is designed for Bachelor and Master students from all disciplines, who wish to improve their English from C1 towards C2 level

The aim is to explore the following questions through texts and film to introduce students to New Zealand and, in a broader sense, to raise

Handouts, online resources, and DVDs of a wide range of NZ films (available in the Self-Access Center -- NB: No hobbits!)

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

The course is only open to students who register on-line via the Sprachenzentrum website during the registration period (review the SZ webpage) and who receive on-line confirmation that they have been accepted on this course.

* Attend regularly throughout the semester
* Participate actively in discussions, group work, and pair work
* Do at least 2 hours' work a week outside the classroom, including reading and writing
* Complete written assignments during the semester

**NB:** This is Part I of a two-part course. Part 2 runs in the spring semester. Each part can be taken on its own. However, a separate enrolment is required for each part.

The course is only open to students who register on-line via the Sprachenzentrum website during the registration period (review the SZ webpage) and who receive on-line confirmation that they have been accepted on this course.

|
| 851-0832-11L | Advanced English for Academic Purposes (C1-C2) W 2 credits 2U R. Taylor |
| 851-0832-10L | Advanced English for Academic Purposes (C1-C2) W 2 credits 2U K. A. Lewis |
| 851-0886-00L | New Zealand Through Literature and Film (C1-C2) W 2 credits 2U M. Norgate |
| 851-0846-01L | Spanish: Grammar and Pragmatic Communication (B2.1) W 2 credits 2U M. Iturrizaga Slosiar |
851-0834-17L  Spanish: Oral Interaction (B2)  
851-0846-02L  Spanish: Language and Cinema (B2-C1)  
851-0826-04L  Italian: Language and Literature (B2-C1)
This course is the first part of a language course which runs over four semesters, covering levels A1 and A2 of the Global European Greek Basic Course Part  I

Materiale didattico

Practice of oral communication and study of basic vocabulary and grammar; focus on noun and adjective structures, personal and possessive pronouns, active verbs (Present Tense) and the use of adverbs. Initiation to web-based activities in Greek language and culture.

Objectives

Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

Literature

851-0885-07L Greek Basic Course Part I

Abstract

Language course for beginners. We will work with a textbook which contains easy original Greek texts. Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

Objective

Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

851-0885-08L Greek Basic Course Part III

Abstract

This is the third semester "Graecum" we consolidate the knowlegde of the language. The course focusses on the lecture of a Platonic dialog and of Homer's Odyssey. The course prepares the students for the final exam in January.

Objective

The students should be able to translate a Greek text on a higher level. They should have a sound knowledge of the Homeric Epos and the Platonic philosophy.

851-0885-09L Modern Greek Language I (A1.1)

Abstract

This course is the first part of a language course which runs over four semesters, covering levels A1 and A2 of the Global European Framework. Modern Greek Language I is designed for students who have no or very little command of Modern Greek and covers level A1.1.

Objective

Practice of oral communication and study of basic vocabulary and grammar; focus on noun and adjective structures, personal and possessive pronouns, active verbs (Present Tense) and the use of adverbs. Initiation to web-based activities in Greek and enhancement of interest and activities in Greek language and culture.

Content

The course covers the areas work, home and personal interests; everyday situations and conversations in hotel, restaurant and shops; asking for the way and asking for advice; simple text materials, such as poems, songs and comics will support learning activities.

Lecture notes

Keines

Literature

- The course book by D. Dimitri & M. Papachimeona, Ellinika tora 1+1 (Greek now 1+1, including 2 audio-CD), units 1-5, Athens 2002, and workbook one, Tetradio Askiseon 1, have been ordered for the course members and are available at "Bücherladen der Stiftung Zentralstelle der Studentenschaft", Schönberggasse 2.
- Web-based activities to support and enhance classroom teaching will be accessible via Moodle, an electronic platform offered by LET of ETHZ (http://moodle.let.ethz.ch/).
- Additional course materials and handouts will be distributed in class.
- A set of 1400 vocabulary cards for the entire coursebook (Ellinika tora 1+1) is available and can be ordered at the beginning of the semester.

Prerequisites / notice

All course participants are expected to:
- attend regularly and participate actively in class
- do at least 3 hours’ work at home
- submit all their written work for correction
- commit themselves to online-activities in the Moodle-LET online-classroom
- pass all semester-tests.

All candidates who fulfill the course requirements will receive a language certificate, issued by the Language Center, awarding 2 ECTS credits.

D-GESS students will receive on-line credit points and marks, in addition to the LC-certificate.

The course is only open to students who register on-line via the Sprachenzentrum-website and who receive online confirmation that they have been accepted on this course. Please note the limited online-registration period!


851-0885-10L Modern Greek Language III (A2.1)

Abstract

This is Part III of the Modern Greek language course, running over four semesters. Modern Greek III covers level A2.1 of the Global European Framework and is designed for students who have already attended courses I and II at the Sprachzentrum UNI/ETHZ, or whose language proficiency is equivalent to level A1.2.

Objective

Extensive vocabulary work (approx. 400 new words); reading of elementary texts; additional practice through speaking only Greek in class; improving listening comprehension; writing short essays (about the past and the future, describing events and personal experience).

Grammar work will focus on verbs (simple past, simple future, subjunctive and imperative; active and passive voice).

Content

Challenging everyday situations; discussion of specific topics (eg. describing pictures and photographs, talking about daily chores); elementary listening comprehension practice (dialogues, talking about events, advertisements); reading comprehension (advertisements, cooking recipies, poems); advanced web-based activities in Greek.

Lecture notes

Keines

Literature

- Audio-visual materials and handouts (photocopies) will be used. Photocopies will be distributed during the semester.
- Web-based activities can be accessed via Moodle platform, supported by LET of ETHZ (http://moodle.let.ethz.ch/).
The participants learn to express themselves in a variety of everyday situations. The course provides knowledge on characteristics of everyday conversation, for instance introducing yourself and others, living and working in an academic context, personal interests, everyday routine, to ask for information and services (in restaurants, coffee-shops, cinemas, theatres, shops) etc.

Students of Greek origin please contact Ms. Rassidakis before enrolling in order to check if the course is not too easy for them.

**851-0889-00L Swedish I (A1)  ■  W  2 credits  2U  F. Kreis**

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

This course is the first of a two part Swedish-course, run over two semesters. The aim of the course is to achieve basic language skills in speaking, listening, reading and writing (Level A1). The focus is based on oral skills. Regular attendance (max 3 absences), active participation in class and a minimum of 3 hours work outside class is expected per week.

Additional material will be distributed during the lessons. You will be asked to pay CHF 5.00 to cover the cost of photocopies.

The course is only open to students who registered online via the Language Center website and who received an e-mail confirmation that they have been accepted in this course.

**851-0889-02L Swedish II (A2.1)  ■  W  2 credits  2U  F. Kreis**

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

This course is a direct continuation of the first part of the Swedish-course. Participants should already have reached level A1. The course aims to work on grammar skills, vocabulary and oral as well as writing skills. Furthermore, Swedish pronunciation should be improved (level A2.1).

The course is only open to students who registered online via the Language Center website and who received an e-mail confirmation that they have been accepted in this course.

**851-0889-01L Polish I (A 1.1)  ■  W  2 credits  2U  S. Schaffner**

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Credits: 2

The course is planned as the first part of a two-semester crash course in Polish at level A1.1. The course covers the four core skills of listening, speaking, reading and writing. We focus on oral communicative skills as well as pronunciation and grammatical structures. Regular attendance (max 3 absences), active participation in class and a minimum of 3 hours work outside class is expected per week.

The students learn to master a set of basic situations in developing communication skills linked with everyday life. Special attention will be given to features of academic culture.

Students learn to master the principles of Polish pronunciation and intonation as well as basic Polish grammar needed to master the course goals.

Coursebook

HURRA!!! Po Polsku 1 (Małgorzata Malolepsza, Aneta Szymkiewicz, ISBN 83-60229-00-7)

Please have a look at the course descriptor Polish I on the Language Center's website (www.sprachenzentrum.uzh.ch/angebot/kurse/index.php?kursangebot) for further information concerning coursebook, CD and grammar to purchase. Participants will be expected to cover the costs of supplementary course handouts provided by the teacher.

The use of of the open-source Learning Management System OLAT will be part of the course.
Students are expected to attend regularly and participate actively in class. Completion of this course requires active and continuous participation. Students should be able to dedicate at least 3 hours a week to independent study activities.

The use of the open-source Learning Management System OLAT will be part of the course.

Assessment:
The assessment will embrace
- a portfolio including exercises done throughout the semester
- a final test assessing the different skills trained.

Requirements for the award of 2 ECTS credits and:
- learning achievement assessed and documented as successful
- no more than 3 absences

851-0851-00L Russian I (A1.1) ■
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Objective
The course focuses on speaking, vocabulary, oral communication in easy everyday life situation, and cultural differences.

Content
These are the contents of the course: talking about food and meals; indicating quantity; saying that one needs something or has to buy something; making sales talk; naming dishes and cutlery; making invitations; asking for an explanation of an unknown term; uttering congratulations and wishes; describing one's day; naming activities in the present, the past and the future; talking about one's way to the working place. The course is supported by the learning platform OLAT.

Lecture notes

851-0853-00L Russian III (A2.1) ■
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Objective
The course focuses on speaking, reading comprehension and auding as well as on cultural competence.

Content
These are the contents of the course: talking about the weather; naming seasons and months; understanding touristic offers; uttering greetings; saying how one is; asking for prices; ordering something in a café; talking about activities; numbers 0-400. The course is supported by the learning platform OLAT.

Lecture notes

851-0855-00L Russian V (A2.2+) ■
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Objective
The course focuses on speaking, reading comprehension and auding as well as on cultural competence on a A2.2+ level according to the "European Framework".

Content
These are the contents of the course: talking about the weather; naming seasons and months; understanding touristic offers; uttering congratulations and wishes; describing one's day; naming activities in the present, the past and the future; talking about one's way to the working place. The course is supported by the learning platform OLAT.

Lecture notes

851-0861-00L Arabic I (A1.1) ■
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course forms the first part (level A1) of a five semesters’ Arabic course. Its aim is to acquire a basic competence on the level of speaking, hearing skills, and also reading and writing of the Arabic script.

Objective
The participants will be able to adequately respond to selected situations of everyday life. Conversations in everyday life and typical situations while traveling will be taught and exercised. Another important focus is the learning of the Arabic script.

Content
Embedded into communicative situations we will work on the following contents: to greet, to present oneself, to talk about oneself (personal identity, occupation, place of living, etc.), simple telephone calls, to ask for information, to book a room. We will pay special attention to cultural aspects.

Literature
Arabisch Intensiv. Grundstufe. Landesspracheninstitut in der Ruhr-Universität Bochum; Buske Verlag (www.buske.de), 2011

851-0861-01L Arabic I (A1.1) ■
Your course registration is only valid with a simultaneous online registration at the language center

W 3 credits 4U E. Youssef-Grob

Assessment:
The assessment will embrace
- a portfolio including exercises done throughout the semester
- a final test assessing the different skills trained.

Requirements for the award of 2 ECTS credits and:
- learning achievement assessed and documented as successful
- no more than 3 absences
The goal is to attain level B1 of the CEF orally and in writing. The class is about acquiring competences needed to deal with literary and scientific texts as well as gaining grammatical and lexical competences on the basis of original texts. The discussion of texts in the original language, in China.

The course aims to bring the participants up to level 2 of the new HSK (standardized international Chinese proficiency test).

The course is open for students, post-graduate students and staff of both Zurich university and ETH without any knowledge of the Arabic language.

The course formation the third semester of a five semesters' Arabic curriculum. We will work on the following topics: Talking about one's life, daily routines, comparisons, wishes, orders, eventualities, preferences. Furthermore, we will pay special attention to acquiring a basic vocabulary and grammar on the Arabic verbal system.

The participants are able to show a culturally and linguistically appropriate behavior in common situations of everyday life. They acquire a basic vocabulary and know the important verbal constructions (present and past tense, imperative, conjunctive).

The course aims to bring the participants up to level 2 of the new HSK (standardized international Chinese proficiency test).

The course is designed for students with a general interest in learning the modern Chinese language or students who are planning to study in China.

The course aims at promoting various everyday communication skills without neglecting their cultural context.

The course has the following aims: the participants shall acquire an advanced competence in the field of speaking, listening, reading and writing. They will build up a number of key characters, so that 300 words should be actively mastered by the end of the semester. Exercises in basic grammatical forms shall give a first understanding of modern Chinese syntax. All the lessons will contain a fair share of conversational practice.

The course forms the third semester of a five semesters' Arabic curriculum. We will work on the following topics: Talking about one's life, daily routines, comparisons, wishes, orders, eventualities, preferences. Furthermore, we will pay special attention to acquiring a basic vocabulary and grammar on the Arabic verbal system.

The course aims to bring the participants up to level 2 of the new HSK (standardized international Chinese proficiency test).

The course is open for students, post-graduate students and staff of both Zurich university and ETH without any knowledge of the Arabic language.

The communicative needs which the practical contents and situations are designed to meet relate to: saying hello, asking about somebody's wellbeing, introducing each other, simple statements about objects and persons, asking for information and services. The participants are expected to do some of their homework on OLAT.

All teaching material besides the reader will be distributed in the lessons and downloaded on OLAT.

Grundstufe

Landesspracheninstitut in der Ruhr-Universität Bochum

Jahr: 2011

Auflage: 3., völlig überarb. Aufl

Prerequisites / notice

The course is open for students, post-graduate students and staff of both Zurich university and ETH without any knowledge of the Arabic language.

851-0863-00L

Arabic III (A2.1)  ■

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract

This course forms the third semester of a five semesters' Arabic curriculum. We will work on the following topics: Talking about one's life, daily routines, comparisons, wishes, orders, eventualities, preferences. Furthermore, we will pay special attention to acquiring a basic vocabulary and grammar on the Arabic verbal system.

Objective

The participants are able to show a culturally and linguistically appropriate behavior in common situations of everyday life. They acquire a basic vocabulary and know the important verbal constructions (present and past tense, imperative, conjunctive).

Content


Literature

Arabisch Intensiv. Grundstufe. Landesspracheninstitut in der Ruhr-Universität Bochum; Buske Verlag (www.buske.de), 2011

Das Lehrmittel ist kurz vor Semesterbeginn erhältlich beim Bücherladen und Studentenladen Zentrum, Schönberggasse 2, 8001 Zürich, Tel: 044 634 45 23, Fax: 044 634 45 26, email: ladenz@zsuz.uzh.ch
geliefert: Mo - Fr 09.00-17.00 Uhr

Prerequisites / notice


851-0866-02L

Arabic Reading Class (B1)  ■

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract

We read short easy or intermediate level texts in the Arabic original and discuss them in Arabic as far as possible. The texts may be literary or deal with simple scientific topics, giving at any rate insights into the culture and society of the Arabic world. Likewise, we shall practice and deepen the competences gained in the previous classes.

Objective

The goal is to attain level B1 of the CEF orally and in writing. The class is about acquiring competences needed to deal with literary and scientific texts as well as gaining grammatical and lexical competences on the basis of original texts. The discussion of texts in the original is designed to encourage oral competence, too.

Literature

Das Lehrmittel ist kurz vor Semesterbeginn erhältlich beim Bücherladen und Studentenladen Zentrum, Schönberggasse 2, 8001 Zürich, Tel: 044 634 45 23, Fax: 044 634 45 26, email: ladenz@zsuz.uzh.ch
geliefert: Mo - Fr 09.00-17.00 Uhr

Prerequisites / notice


851-0877-02L

Chinese I (A1.1)  ■

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract

This course is designed for students with a general interest in learning the modern Chinese language or students who are planning to study in China.

Objective

The course aims at promoting various everyday communication skills without neglecting their cultural context.

Content

Introduction to the modern standard Chinese language (Mandarin) and script, concentrating on basic vocabulary in Pinyin and Chinese characters, elementary grammar and conversation. The main focus will be on colloquial language.

Literature

Wir arbeiten mit folgendem Lehrmittel: Zhngoinghuá, shàngcè und Zhongguózì, shxi (Beijing, 2007 mit Audio CD).

851-0879-00L

Chinese III (A2.1)  ■

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract

Building on course Chinese II the students will learn to actively master a vocabulary of 300 words. In addition, the course will teach some of the basic grammatical patterns. Exercises in spoken Chinese covering a number of topics are also part of the course-work. The course aims to bring the participants up to level 2 of the new HSK (standardized international Chinese proficiency test).

Objective

The course has the following aims: the participants shall acquire an advanced competence in the field of speaking, listening, reading and writing. They will build up a number of key characters, so that 300 words should be actively mastered by the end of the semester. Exercises in basic grammatical forms shall give a first understanding of modern Chinese syntax. All the lessons will contain a fair share of conversational practice.
**Content**

- **Neue erworbene Sprachkompetenzen:**
  1. Die Fähigkeit, Zahlen und Mengen in der korrekten grammatischen Form anzuwenden.
  2. Eine eigene Meinung richtig äußern (z. B. Gefühle bewerten können).
  3. Nach der Meinung der anderen fragen können.
  4. Einen Vorschlag machen können.
  5. Zwei Dinge miteinander vergleichen können.
  7. Gegenwart, Vergangenheit und Zukunft ausdrücken können.

**Literature**

Wir arbeiten mit folgendem Lehrmittel:

1. Heinrich Reinfried "Kompaktlehrgang Japanisch" oder

**Prerequisites / notice**

Vorausgesetzt wird der Besuch der Chinesisch I und II Kurse oder eine äquivalente Sprachkompetenz. Teilnehmende, welche die beiden ersten Kurse nicht besucht haben, werden gebeten, sich mit der Kursleiterin in Verbindung zu setzen.

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**851-0879-01L Chinese V (A2.2+)**

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

*Abstract*

This course is meant for all students and employees at the University and the ETH Zurich. Members of the course will acquire an advanced linguistic competence meeting the new standards set by Chinese as a Foreign Language (level B1).

Content

Building on the results of course Chinese V the students will learn a basic vocabulary of about 600 characters. Until the end of the course they will acquire the capacity not only to read but also to write these characters. The students will be familiarized with the new vocabulary through a number of exercises involving dialogues and short sentences. In addition, the competence in understanding spoken colloquial Chinese will also be trained.

Prerequisites / notice

Diejenigen Studierenden, die ihre Sprachstudien weiterführen oder die Standardprüfung für Chinesisch als Fremdsprache (HSK) ablegen wollen, sollen Gelegenheit erhalten, ihre Lese- und Schreibfähigkeit zu verbessern und sich schrittweise ein umfangreicheres Vokabular anzeuge

Objectives

Learning the results of course Chinese V the students will learn a basic vocabulary of about 600 characters. Until the end of the course they will acquire the capacity not only to read but also to write these characters. The students will be familiarized with the new vocabulary through a number of exercises involving dialogues and short sentences. In addition, the competence in understanding spoken colloquial Chinese will also be trained.

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**851-0881-00L Japanese I (A1.1)**

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

*Abstract*

Elementary introduction to the Japanese language. Students acquire the basic language skills needed for everyday life communicative interactions.

Objective

Level A1.1 of the Common European Framework of Reference for Languages (CEFR).

Content

1. The capacity to express one's own opinions correctly (e.g. be able to evaluate feelings).
2. To be able to make proposals.
3. To be able to compare two things.
4. To be able to explain the cause of something.
5. To be able to express present, past and future tenses.

---

**851-0881-01L Japanese I (A1.1)**

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

*Abstract*

Elementary introduction to the Japanese language. Students acquire a basic vocabulary together with the most frequently used sentence structures, as well as the Hiragana and Katakana syllabaries. Reading and writing training includes use of the computer for Japanese text editing.

Objective

Elementary introduction to the Japanese language. Students acquire a basic vocabulary together with the most frequently used sentence structures, as well as the Hiragana and Katakana syllabaries. Reading and writing training includes use of the computer for Japanese text editing.

Content

1. Heinrich Reinfried, "Kompaktlehrgang Japanisch" (available at the beginning of the course, later by mail to reinfried@asiaintensiv.ch; also available in English: "Concise course in Japanese")
2. "Japanisch Intensiv", LSI Bochum (Verlag Buske)

Lecture notes

- Heinrich Reinfried, "Kompaktlehrgang Japanisch" (available at the beginning of the course, later by mail to reinfried@asiaintensiv.ch; also available in English: "Concise course in Japanese")
- "Japanisch Intensiv", LSI Bochum (Verlag Buske)

This will be sold at the beginning of the course or can be ordered directly at www.asiaintensiv.ch.

---

**851-0883-00L Japanese III (A2.1)**

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

*Abstract*

Training in colloquial Japanese / Reading of common texts in Japanese / Application, consolidation and expansion of the basic vocabulary and sentence structures / Training in hearing

Objective

The participants consolidate and broaden the basic knowledge of the modern colloquial language in Japan. One of the focuses is on the acquisition of speech methods for important everyday standard situations. At the same time the grammar knowledge will be repeated and broadened. Higher reading skills will also be strived for by learning approx. 60 new Kanji.
**Lecture notes**
We will be using this textbook: "Japanisch Intensiv Grundkurs", LSI, Buske Verlag

**Content**
For details see www.sprachenzentrum.uzh.ch

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Dr</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0882-02L</td>
<td>Japanese V: Readings in Modern Japanese (A2.2-B1)</td>
<td>2</td>
<td>W</td>
<td>G</td>
<td>G. Gefter</td>
</tr>
</tbody>
</table>

**Abstract**
The focus of this course is on the reading of challenging original texts from Japanese media and Japanese contemporary literature. The texts are analyzed and discussed in terms of their content and linguistic features.

**Objective**
By reading selected original texts, students learn strategies for reading texts analytically. The aim is that they are able to handle Japanese sources independently, using appropriate tools.

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Dr</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0890-00L</td>
<td>Reading Course Latin: Hannibal ad portas</td>
<td>2</td>
<td>W</td>
<td>C</td>
<td>C. Utzinger</td>
</tr>
</tbody>
</table>

**Abstract**
The general topic of the course is Hannibal. On the basis of didactically prepared texts written by various Latin authors (including Nepos, Livy) this enigmatic figure who stood before the gates of Rome in 215 BC is examined.

**Objective**
Students mostly prepare the texts at home for class discussion. Furthermore, important topics of basic grammar are reviewed (exercises).

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Dr</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0900-01L</td>
<td>Norwegian I (University of Zürich)</td>
<td>3</td>
<td>W</td>
<td>E</td>
<td>E. Berg</td>
</tr>
</tbody>
</table>

**Abstract**
This language course is an introduction to Norwegian (Bokmål) as well as to the country and its culture.

**Objective**
By the end of the course, you will have read some easy Norwegian texts, have written your first own texts, and be able to conduct simple conversations.

**Literature**

**Prerequisites / notice**
You are recommended to take part in the tutorial offered for this course.

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<tr>
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<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Dr</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0900-03L</td>
<td>Norwegian III (University of Zürich)</td>
<td>3</td>
<td>W</td>
<td>E</td>
<td>E. Berg</td>
</tr>
</tbody>
</table>

**Abstract**
The third part of the Norwegian-course aims at a further development of your active and passive language competence. You will finish the textbook and round it off by an individual assignment on a Norwegian theme.

**Objective**
You will be reading Norwegian literature with ease and discussing various themes both in speech and in writing.

**Literature**

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Dr</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0900-04L</td>
<td>Norwegian IV (University of Zürich)</td>
<td>3</td>
<td>W</td>
<td>E</td>
<td>E. Berg</td>
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</tbody>
</table>

**Abstract**
After completing the three semester basic course, the fourth semester will focus on active language competencies. Based on current topics in Norwegian media, you will practice reading, hearing, discussing and writing in Norwegian.

**Objective**
You will master the Norwegian language well enough to be able to discuss and write about complex matters.

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**GESS Compulsory Electives Course - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
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</table>

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## Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
<td></td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td>Abstract: This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<tr>
<td></td>
<td>Objective: - Get information about recent literature on learning and instruction</td>
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<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td></td>
<td>Prerequisites / notice: Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td></td>
<td>Lecturers: E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td>Abstract: The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td>Objective: - Understanding research methods used in the empirical human sciences</td>
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<td></td>
<td>- Getting to know intelligence tests</td>
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<td></td>
<td>- Understanding findings relevant for education</td>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>Abstract: Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td>Objective: - Understand research methods used in the empirical educational sciences</td>
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<tr>
<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<tr>
<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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<tr>
<td></td>
<td>Abstract: In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<td></td>
<td>Objective: The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction).</td>
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</table>

Learning goals include:  
- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.  
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.  
- Participants can design and conduct a study that is relevant for answering their research question.  
- Participants can summarize and evaluate the main results from a study in the field of learning and instruction, with regard to the research question being asked.

### Subject Didactics in Geography

See Educational Science Teaching Diploma

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Data: 06.12.2018 13:04  Autumn Semester 2015  Page 638 of 1432
The course introduces students to the practical side of geography teaching. Participants look into the understanding of this school subject over the course of time and learn:

- how to plan their teaching in the context of the valid curricula, including on an interdisciplinary basis.
- how geographical contents can be implemented in didactic and methodological terms so as to ensure that fundamental competences can be imparted to pupils (knowledge, skills, attitudes), with a view to university studies as well.
- how to foster pupils in such a way that they can think independently in terms of spatial competence and can act in a responsible manner.

Abstract

Theoretical Konzepte werden präsentiert und an Beispielen diskutiert. Die Studierenden setzen sich mit Methoden aktiv auseinander (z.B. Lernpuzzle, Fallstudie sowie sozial- und Aktionsformen) und reflektieren dabei ihre eigenen Schülerfahrungen im Fach.

Lecture notes

Unterlagen aus der Fachdidaktischen Ausbildung

Literature


Prerequisites / notice


Content

Thematische Schwerpunkte
- Einführung in die Theorie der Geografiendidaktik.
- Bildungsauftrag der Geografie an Mittelschulen.
- Interesse der Lernenden am Geografieunterricht.
- Unterrichtsgestaltung und -vorbereitung: Sachanalyse, lernzielorientierte Unterrichtsplanung; Didaktische Analyse; Einführung in die Gestaltung von Lernarrangements.
- Mediendidaktik (Arbeiten mit Bildern und Karten).
- Planung einer Unterrichtseinheit (Struktur - Prozess - Verlauf).

Lernformen

Theoretische Konzepte werden präsentiert und an Beispielen diskutiert. Die Studierenden setzen sich mit Methoden aktiv auseinander (z.B. Lernpuzzle, Fallstudie sowie Sozial- und Aktionsformen) und reflektieren dabei ihre eigenen Schülerfahrungen im Fach.

Lecture notes

Unterlagen aus der Fachdidaktik

Literature


Prerequisites / notice


Content

Thematische Schwerpunkte
- Einführung in die Theorie der Geografiendidaktik.
- Bildungsauftrag der Geografie an Mittelschulen.
- Interesse der Lernenden am Geografieunterricht.
- Unterrichtsgestaltung und -vorbereitung: Sachanalyse, lernzielorientierte Unterrichtsplanung; Didaktische Analyse; Einführung in die Gestaltung von Lernarrangements.
- Mediendidaktik (Arbeiten mit Bildern und Karten).
- Planung einer Unterrichtseinheit (Struktur - Prozess - Verlauf).

Lernformen

Theoretische Konzepte werden präsentiert und an Beispielen diskutiert. Die Studierenden setzen sich mit Methoden aktiv auseinander (z.B. Lernpuzzle, Fallstudie sowie Sozial- und Aktionsformen) und reflektieren dabei ihre eigenen Schülerfahrungen im Fach.

Lecture notes

Unterlagen aus der Fachdidaktik

Literature


Prerequisites / notice


Content

Thematische Schwerpunkte
- Einführung in die Theorie der Geografiendidaktik.
- Bildungsauftrag der Geografie an Mittelschulen.
- Interesse der Lernenden am Geografieunterricht.
- Unterrichtsgestaltung und -vorbereitung: Sachanalyse, lernzielorientierte Unterrichtsplanung; Didaktische Analyse; Einführung in die Gestaltung von Lernarrangements.
- Mediendidaktik (Arbeiten mit Bildern und Karten).
- Planung einer Unterrichtseinheit (Struktur - Prozess - Verlauf).

Lernformen

Theoretische Konzepte werden präsentiert und an Beispielen diskutiert. Die Studierenden setzen sich mit Methoden aktiv auseinander (z.B. Lernpuzzle, Fallstudie sowie Sozial- und Aktionsformen) und reflektieren dabei ihre eigenen Schülerfahrungen im Fach.

Lecture notes

Unterlagen aus der Fachdidaktik

Literature


Prerequisites / notice


Content

Thematische Schwerpunkte
- Einführung in die Theorie der Geografiendidaktik.
- Bildungsauftrag der Geografie an Mittelschulen.
- Interesse der Lernenden am Geografieunterricht.
- Unterrichtsgestaltung und -vorbereitung: Sachanalyse, lernzielorientierte Unterrichtsplanung; Didaktische Analyse; Einführung in die Gestaltung von Lernarrangements.
- Mediendidaktik (Arbeiten mit Bildern und Karten).
- Planung einer Unterrichtseinheit (Struktur - Prozess - Verlauf).

Lernformen

Theoretische Konzepte werden präsentiert und an Beispielen diskutiert. Die Studierenden setzen sich mit Methoden aktiv auseinander (z.B. Lernpuzzle, Fallstudie sowie Sozial- und Aktionsformen) und reflektieren dabei ihre eigenen Schülerfahrungen im Fach.

Lecture notes

Unterlagen aus der Fachdidaktik

Literature

Prerequisites: successful participation in Geography Didactics of Geography Teaching I+II (651-4239-00L and 651-2500-00L).

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
The Subject Didactics III course unit comprises two blocks: one "Specialisation" block with key subjects from courses I and II and a block on "Information technology in geography teaching" with specific applications.

Objective
In Subject Didactics III, students take a more in-depth, application-oriented look at geography. Students
- learn about the options for using ICT to design their geography teaching and also the integral furtherance of pupils' IT competence. They plan an IT lesson, hold it and then evaluate it.
- identify the opportunities and limits of illustrating their geography teaching with films, models and experiments.
- look into the significance of the subjective theories for learning success and failure and discuss tuition options for a concept change (geographical case studies).

Content
Inhalt
Fachdidaktik III Block "Vertiefung" (1/2 Semester)
- Planung von Unterrichtseinheiten.
Fachdidaktik III Block "ICT im Geografieunterricht" (1/2 Semester)
- Fachspezifische Einsatzmöglichkeiten, Unterrichtshilfen, konkrete Anwendungen und Resultate an Beispielen kritisch reflektieren.
(Leistungsnachweis).

Lernformen
Theoretische Konzepte werden vorgestellt und an typischen Beispielen aus der Praxis illustriert. Beispiele im IT- Bereich werden von Studierenden selbst erarbeitet ("Werkstatt"), präsentiert und diskutiert.

Lecture notes
Unterlagen werden abgegeben.

Literature
Weitere Literaturangaben.

Prerequisites / notice
Fachdidaktik III kann im Frühlingssemester parallel zu Fachdidaktik II besucht werden, aber erst nach Fachdidaktik I.

► Professional Training in Geography

★★ Professional Training (First Subject)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-2519-01L</td>
<td>Introductory Internship (University of Zürich)</td>
<td>O</td>
<td>1 credit</td>
<td>2P</td>
<td>B. Vettiger-Gallusser</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090BPA12

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) and Geography Didactics I (651-4239-00L) is compulsory.

Abstract
The Introductory Internship belongs to the parctical expertise education of the teacher training for Upper Secondary Schools and must be completed at the beginning of studies.

Prerequisites / notice
The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).

| 651-2519-02L | Practice Lessons for Didactics I an II (University of Zurich) | O    | 2 credits | 4P   | B. Vettiger-Gallusser |

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090BPU1

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) and Geography Didactics I (651-4239-00L) is compulsory.

Abstract
The practice lessons help students to gain first experiences in teaching and reflect the courses of the teacher training and didactics. Accurate planning (preliminary discussion, written proposal) is an integral part of this course as well as a wrap-up.

Prerequisites / notice
The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).

| 651-2517-00L | Teaching Internship Geography (University of Zürich) | O    | 8 credits | 17P  | B. Vettiger-Gallusser |

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090BPU1

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Prerequisites: Successful completion of Educational Science and Subject Didactics in Geography (FD I, II, III) as well as Spec. Courses in Resp. Subj. w/ Educ. Focus & Further Subj. Didactics (FV I, II, III) plus completion of the introductory internship.
The Teaching Internship takes place after successful completion of the didactics courses I, II incl. practice lessons. The teaching internship takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching internship lasts a maximum of 10 weeks.

The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).

**651-2520-01L** Examination Lesson I Geography
Simultaneous enrolment in "Examination Lesson II Geography" (651-2520-02L) is compulsory.

**Abstract**
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

**Objective**
On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and, outline improvements.

**Content**
Die Studierenden erfahren das Lektionsthema in der Regel 14 Tage vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie spätestens 2 Tage vor der Prüfung (bis 18 Uhr) den beiden Prüfungsexperten ein.

Die gehaltene Lektion wird kriteriumbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/ der Kandidatin über die gehaltene Lektion im Rahmen eines Kolloquiums (15 min).

**Prerequisites / notice**
Bitte bei der Prüfungsanmeldung den schriftlichen Nachweis erbringen, dass die ganze Ausbildung abgeschlossen ist.

**651-2520-02L** Examination Lesson II Geography
Simultaneous enrolment in "Examination Lesson I Geography" (651-2520-01L) is compulsory.

**Abstract**
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

**Objective**
On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and, outline improvements.

**Content**
Die Studierenden erfahren das Lektionsthema in der Regel 14 Tage vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie spätestens 2 Tage vor der Prüfung (bis 18 Uhr) den beiden Prüfungsexperten ein.

Die gehaltene Lektion wird kriteriumbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/ der Kandidatin über die gehaltene Lektion im Rahmen eines Kolloquiums (15 min).

**Prerequisites / notice**
Bitte bei der Prüfungsanmeldung den schriftlichen Nachweis erbringen, dass die ganze Ausbildung abgeschlossen ist.

**651-4137-00L** Professional Exercises (University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

**Abstract**
In the context of their teaching practice, students compile a portfolio in which they analyse and document selected aspects of their teaching experience.

**Objective**
- To analyze the tuition they have given with regard to its strengths and weaknesses, and, outline improvements.
- To develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- To analyze the tuition they have given with regard to its strengths and weaknesses, and, outline improvements.

**Content**
- Erstellen eines Portfolios zum Praktikumsjournal (6-8 Seiten) und den dazu gehörenden Dokumenten (z.B. einem Beobachtungsprotokoll; einer Unterrichtsplanung; einer Lernaufgabe; einer Prüfung;)
- Vorgängige Überlegungen (Problemstellung bzw. Vorbereitung einzelner Lektionen) werden schriftlich dokumentiert sowie die Erfahrungen reflektiert, die bei der Umsetzung und Durchführung des Unterrichts gemacht wurden.
- Im Praktikumsjournal sollen fachwissenschaftliche Aspekte, allgemein- und fachdidaktische Überlegungen, fachlich-pädagogische und didaktische Aspekte sowie konkrete Erfahrungen aus dem Praktikum einbezogen und angemessen miteinander in Verbindung gebracht werden.
- Die Art der Darstellung des Portfolios wird durch die Studierenden bestimmt.
- Der Hauptteil des Praktikumsjournals umfasst ca. sechs bis acht Seiten.
- Formal muss das Praktikumsjournal der Struktur einer wissenschaftlichen Arbeit entsprechen (Titelblatt, Inhaltsverzeichnis, Hauptteil, Schlusswort, Literatur- und Materialienangaben).

**Prerequisites / notice**

**Professional Training (Two Subjects in One-Step Procedure)**

*The programme "Teaching Diploma, Two Subjects in One-Step Procedure" will not be offered anymore since Autumn Semester 2010. Therefore new
### Introductory Internship (University of Zürich)

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

#### Abstract

The Introductory Internship belongs to the practical expertise education of the teacher training for Upper Secondary Schools and must be completed at the beginning of studies.

#### Prerequisites / notice

The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).

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<td>651-4239-00L</td>
<td>Geography Didactics Geography I (University of Zürich)</td>
<td>O</td>
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<td>Simultaneous enrolment in Introductory Internship Geography (651-4239-00L) is compulsory.</td>
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</table>

Abstract

Fundamentals (theory and practice) of specialist subject teaching for high-school geography lessons.

Objective

The course introduces students to the practical side of geography teaching. Participants look into the understanding of this school subject over the course of time and learn:

- how to plan their teaching in the context of the valid curricula, including on an interdisciplinary basis;
- how geographical contents can be implemented in didactic and methodological terms so as to ensure that fundamental competences can be imparted to pupils (knowledge, skills, attitudes), with a view to university studies as well;
- how to foster pupils in such a way that they can think independently in terms of spatial competence and can act in a responsible manner.

Content

Thematic Schwerpunkte

- Einführung in die Theorie der Geografiedidaktik,
- Bildungsauftrag der Geografie an Mittelschulen,
- Interesse der Lernenden am Geografieunterricht,
- Unterrichtsgestaltung und -vorbereitung: Sachanalyse, lernzielorientierte Unterrichtsplanung; Didaktische Analyse; Einführung in die Gestaltung von Lernarrangements;
- Mediendidaktik (Arbeiten mit Bildern und Karten);
- Planung einer Unterrichtseinheit (Struktur - Prozess - Verlauf).

Lernformen

Theoretische Konzepte werden präsentiert und an Beispielen diskutiert. Die Studierenden setzen sich mit Methoden aktiv auseinander (z.B. Lernpuzzle, Fallstudie sowie Sozial- und Aktionsformen) und reflektieren dabei ihre eigenen Schülererfahrungen im Fach.

Lecture notes

Unterlagen werden abgegeben.

Literature


Prerequisites / notice

Fachdidaktik I ist gleichzeitig mit dem Einführungspraktikum zu belegen.

Sie gilt als Voraussetzung für Fachdidaktik II und III, sowie die FWV II und FWV III.

Fachdidaktik III findet nur im Sommersemester statt.

Fachdidaktik III kann parallel zur Fachdidaktik II im Sommersemester oder parallel zur FWV III (Ringvorlesung und FD-Seminar) im Herbstsemester belegt werden.


Teaching Internship Geography

Prerequisites: successful participation in Geography Didactics I-III.

Teaching Internship Geography for Teaching Diploma in 2 Subjects in One-Step Procedure and Geography as Major Subject.

Abstract

In the final phase of their training, students have to apply and test the insights, abilities and skills they have acquired. They spend 3-5 weeks in an educational institution, during which time they observe 10 lessons and teach 30 lessons independently.

Objective

Die Studierenden können die Bedeutung von Unterrichtsthemen unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbare (Fach-)Wissen zu erwerben.

Content


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<tr>
<th>Number</th>
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<tr>
<td>651-4237-01L</td>
<td>Specialised Courses in the Respective Subject with an Educational Focus Geography</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>University lecturers</td>
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</table>

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

It is recommended to attend the lecture series and seminar after Geography Didactics I - III.

Abstract

Current approaches to research which are of relevance to society are presented on the basis of examples and critically examined in respect of their significance for a high-school education in the subject of geography.

Objective

- Students
  - look at the subject knowledge in its full breadth, on the basis of current approaches to research and with the consideration of specific examples, thereby creating a specialised basis on which to critically examine specialist contents for the school subject of geography, as part of a general education, over the course of time.
  - see whether and where current topics from the specialist subject (research) can be incorporated in secondary-school tuition.
  - familiarise themselves with questions and forms of cognition-oriented, moderately constructivist tuition.
  - can reflect on geography teaching in an aware and theory-based manner.
Content

Vorlesung:
In jeweils in sich geschlossenen Vorlesungen beleuchten Dozierende die gesellschaftliche Relevanz ihrer aktuellen Forschungsansätze an konkreten Beispielen aus der Physischen Geografie und den Erdwissenschaften, der Humangeografie sowie der Methodischen Geografie. Sie thematisieren dabei die Bedeutung der Ansätze für die Gesellschaft zur Auseinandersetzung mit räumlichen Fragestellungen und Problemlösungen und diskutieren die aus ihrem Forschungsansatz und den Ergebnissen resulterenden ethischen Fragen. Sie beleuchten damit die Breite des Fachverständnisses und legen das Fundament für die kritische Auseinandersetzung mit den allgemein bildenden Fachinhalten (Kompetenzen, Fachwissen, Einstellungen), die insbesondere in der gymnasialen Ausbildung im Fach Geographie vermittelt werden sollen.

Lecture notes

Zu jeder Vorlesung werden Folien/Unterlagen abgegeben.

Literature

Wird von den jeweils verantwortlichen Dozierenden zusammengestellt.

Prerequisites / notice


Es wird sehr empfohlen, dieses Modul parallel zum Unterrichtspraktikum zu besuchen.

<table>
<thead>
<tr>
<th>Code</th>
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<td>651-4237-02L</td>
<td>Specialised Courses in the Respective Subject with an O</td>
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<td>credits</td>
<td>B. Vettiger-Gallusser</td>
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<tr>
<td>Educational Focus Geography FVIII</td>
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<tr>
<td>The lecture series and seminar can only be attended after successful completion of Geography Didactics I.</td>
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Abstract

Current approaches to research which are of relevance to society are presented on the basis of examples and critically examined in respect of their significance for a high-school education in the subject of geography.

Objective

Students
- look at the subject knowledge in its full breadth, on the basis of current approaches to research and with the consideration of specific examples, thereby creating a specialised basis on which to critically examine specialist contents for the school subject of geography, as part of a general education, over the course of time.
- see whether and where current topics from the specialist subject (research) can be incorporated in secondary-school tuition.
- familiarise themselves with questions and forms of cognition-oriented, moderately constructivist tuition.
- can reflect on geography teaching in an aware and theory-based manner.

Content

Seminario:
- Einführung in den Umgang mit theoretischen Konzepten zur kritischen Reflexion von Unterrichtsinhalten und -methoden hinsichtlich ihrer Ausrichtung.
- Auseinandersetzung mit Wesen und Inhalt der geographischen Allgemeinbildung, ihren Möglichkeiten und Grenzen (z.B. Ressourcen, Lehrpläne) mit direktem Bezug zur Ringvorlesung.
- Berücksichtigung der Wissensgenese sowie ethischer und methodischer Aspekte für die Ausbildung an Maturitätsschulen.
- Diskussion von Unterrichtsinhalten und Lernarrangements unter Berücksichtigung der vermittelten Impulse und fachdidaktischer Literatur.

Lernformen:
Die fachwissenschaftlichen Aspekte werden in der Form einer Vorlesung von verschiedenen Dozierenden von der UZH und ETHZ präsentiert.
Im Seminar erfolgt eine kritische Diskussion und Aufarbeitung der exemplarischen Bedeutung der einzelnen Vorlesungsinhalte an Hand von Kurzvorträgen der Studierenden und bestehender Lehr-/ Lernmaterialien. Konkrete Umsetzungsempfehlungen mit Bezug zu behandelten Themen der Ringvorlesung für den Unterricht als Seminararbeit (Partnerarbeit) werden erstellt.

Lecture notes

Zu jeder Seminarveranstaltung werden Folien/ Unterlagen abgegeben.

Literature

Wird von den jeweils verantwortlichen Dozierenden zusammengestellt.

Prerequisites / notice


Es wird sehr empfohlen, dieses Modul parallel zum Unterrichtspraktikum zu besuchen.

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<td>credits</td>
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Abstract

Participants conduct a critical examination of regional geography in terms of the understanding of the subject and teaching in schools, and its potential for substantiated tuition is established.

Objective

Regional geography observes delimited partial areas, mapped to different scales, considering thematic and exemplary aspects. Regional geography features in this form on a large number of geography syllabuses. Against this background, the module comprises two parts. A specialist lecture on the subject takes a specific regional example to highlight current, interdisciplinary topics and case studies. The aim here is to compile specialist contextual knowledge about a region. In an accompanying seminar, this contextual knowledge is then put in the correct practical form for teaching in a school, thus ensuring that the teachers are in a position to configure regional geography teaching that has been duly reflected on from the specialist-subject, didactic and pedagogical angle.
Participants conduct a critical examination of regional geography in terms of the understanding of the subject and teaching in schools, and its potential for substantiated tuition is established.

Regional geography observes delimited partial areas, mapped to different scales, considering thematic and exemplary aspects. Regional geography features in this form on a large number of geography syllabuses. Against this background, the module comprises two parts. A specialist lecture on the subject takes a specific regional example to highlight current, interdisciplinary topics and case studies. The aim here is to compile specialist contextual knowledge about a region. In an accompanying seminar, this contextual knowledge is then put in the correct practical form for teaching in a school, thus ensuring that the teachers are in a position to configure regional geography teaching that has been duly reflected on from the specialist-subject, didactic and pedagogical angle.

Objective
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Content
- Übersicht über Themen, die für eine Region typisch sind oder sich in einer Region abspielen (z. B. Arabische Halbinsel, Afrika südlich der Sahara, Asien)
- Regionale Fallstudien mit interdisziplinärem Charakter
- Differenzierte Auseinandersetzung mit kulturellen und politischen Fragen und Entwicklungslagen in einer Region
- Erarbeiten von bedeutenden fachwissenschaftlichen Debatten zu einer Region

Seminar
- Regional-thematische Geografie versus traditionelle Länderkunde
- Geografisches Orientierungsverstehen: Stellenwert
- Werteerziehung und Interdisziplinarität im regionalgeografischen Kontext
- Didaktische Analyse und Planung regionalgeografischen Unterrichts: Von der Sachanalyse über den Einstieg bis zur Bewertung
- Methoden und Recherche in der Regionalgeografie

Lernformen
Fachwissenschaftliche Aspekte werden in der Form einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde die Inhalte und setzen diese im Hinblick auf die Schulpraxis um. Dabei wird ein elektronisches Lernstagebuch geführt und über eine Lernplattform über die schulpraktische Umsetzung reflektiert. Es werden auch Materialien zusammengestellt.

Lecture notes
Folien werden zur Verfügung gestellt.

Literature
Wird je nach regionalen Fokus zusammengestellt.

651-4247-10L Regional Geography: Lecture and Didactic Concept Japan (University of Zurich) 3 credits 2V University lecturers

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO784

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

651-4247-30L Regional Geography: Lecture and Didactic Concept Australia and Newzealand (UZH) 3 credits 2V University lecturers

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO789

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Objective
Regional geography observes delimited partial areas, mapped to different scales, considering thematic and exemplary aspects. Regional geography features in this form on a large number of geography syllabuses. Against this background, the module comprises two parts. A specialist lecture on the subject takes a specific regional example to highlight current, interdisciplinary topics and case studies. The aim here is to compile specialist contextual knowledge about a region. In an accompanying seminar, this contextual knowledge is then put in the correct practical form for teaching in a school, thus ensuring that the teachers are in a position to configure regional geography teaching that has been duly reflected on from the specialist-subject, didactic and pedagogical angle.
Content
- Vorlesung
- Übersicht über Themen, die für eine Region typisch sind oder sich in einer Region abspielen (z. B. Arabische Halbinsel, Afrika südlich der Sahara, Asien)
- Regionale Fallstudien mit interdisziplinärem Charakter
- Differenzierte Auseinandersetzung mit kulturellen und politischen Fragen und Entwicklungen in einer Region
- Erarbeiten von bedeutenden fachwissenschaftlichen Debatten zu einer Region

Seminar
- Regional-thematische Geografie versus traditionelle Länderkunde
- Geografisches Orientierungswissen: Stellenwert
- Werteerziehung und Interdisziplinarität im regionalgeografischen Kontext
- Didaktische Analyse und Planung regionalgeografischer Unterrichts: Von der Sachanalyse über den Einstieg bis zur Bewertung
- Methoden und Recherche in der Regionalgeografie

Lernformen
Fachwissenschaftliche Aspekte werden in der Form einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde die Inhalte und setzen diese im Hinblick auf die Schulpraxis um. Dabei wird ein elektronisches Lerntagebuch geführt und über eine Lernplattform über die schulpraktische Umsetzung reflektiert. Es werden auch Materialien zusammengestellt.

Lecture notes
Folien werden zur Verfügung gestellt.

Literature
Wird je nach regionalen Fokus zusammengestellt.

Compulsory Elective Courses
Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

see Compulsory Elective Courses Teaching Diploma

Additional Requirements (ETH-Masterstudents in ERDW and AC)

Part 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-2601-00L</td>
<td>Human Geography I: One Earth - Many Worlds (University of Zürich)</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>University lecturers</td>
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<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO972</td>
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<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Imparting of research questions and basic principles in Human Geography</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>(1) Society and space (2) Society and development (structure and dynamic of population, urbanisation, disparities (3) Society and natural environment (natural resources, food security, sustainability)</td>
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<td></td>
<td>PowerPoint-slides (German)</td>
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<td>Literature</td>
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<tr>
<td>651-4121-00L</td>
<td>Introduction to Cartography and Visualization (University of Zürich)</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH, course moved to spring semester.</td>
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<td></td>
<td>UZH Module Code: GEO975</td>
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<td>Abstract</td>
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<tr>
<td></td>
<td>Exercices to the course Introduction Remote Sensing.</td>
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</table>

Part 2

<table>
<thead>
<tr>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-3338-00L</td>
<td>Remote Sensing and Geographic Information Science III (University of Zürich)</td>
<td>O</td>
<td>5 credits</td>
<td>3U</td>
<td>University lecturers</td>
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<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO233</td>
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<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Exercises to the course Introduction Remote Sensing.</td>
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<tr>
<td>651-4088-03L</td>
<td>Physical Geography III (Geomorphology and Glaciology) (University of Zürich)</td>
<td>W</td>
<td>5 credits</td>
<td>1V+1U</td>
<td>University lecturers</td>
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<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO231</td>
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<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Das Modul bietet eine kurze Einführung in einige Komponenten und Prozesse des hydrologischen Kreislaufs. Dabei werden einzelne Wasserspeicher (Schnee-, Boden und Grundwasser) und Flüsse zwischen den Speichern (Verdunstung, Niederschlag und Abfluss) betrachtet. Übungen ergänzen die Vorlesung.</td>
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<tr>
<td>651-2613-00L</td>
<td>Humangography III (Geographies of Difference) (Universität Zürich)</td>
<td>W</td>
<td>5 credits</td>
<td>1G+2S</td>
<td>University lecturers</td>
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<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.</td>
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</table>
UZH Module Code: GEO232

Prerequisite: Human Geography II (UZH Module Code: GEO122)

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Teil GEO232.1:
Das Seminar verfolgt das Ziel, ein tieferes Verständnis für sozialwissenschaftliche Grundlagen der Humangeographie zu gewinnen.
Teil GEO232.2:
In der Vorlesung und den Tutorien werden aktuelle wirtschaftsgeographische Themen behandelt. Demonstriert und erklärt wird insbesondere, wie die Wirtschaft mit Grenzen und Grenzziehungen umgeht.

Objective
- Sie vertiefen ihre theoretischen, empirischen und methodischen Fähigkeiten in folgenden Themenbereichen:
  - Gesellschaft und Raum
  - Gesellschaft und Entwicklung
  - Gesellschaft und natürliche Umwelt/Ressourcen
  - Offenheit und Geschlossenheit in Wirtschaft und Gesellschaft
  - Chancen und Herausforderungen einer globalisierten Weltwirtschaft
- Sie sind in der Lage, Verknüpfungen zwischen grundlegenden sozial- und wirtschaftswissenschaftlichen Theorien und deren Konkretisierung in der Geographie herzustellen.
- Sie können die erwähnten Themen mit ausgewähltem Faktenwissen verknüpfen und diskutieren
- Sie schulen Ihre analytischen und theoretischen Fähigkeiten und können diese in Diskussionen einbringen
- Sie können die Relevanz von weiterführenden wissenschaftlichen Texten diskutieren und mit einem Ausgangstext verknüpfen
- Sie sind in der Lage, eine Diskussion über wissenschaftliche Themen zu strukturieren und - mit einfachen Moderationstechniken - zu moderieren

Prerequisites / notice
Besuch von GEO122.

Geography Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
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<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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Key for Hours

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<tr>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0241-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7 credits</td>
<td>5+2U</td>
<td>M. Akveld</td>
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<tr>
<td>Abstract</td>
<td>Mathematical tools for the engineer</td>
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<tr>
<td>Objective</td>
<td>Mathematics as a tool to solve engineering problems.</td>
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<tr>
<td>Content</td>
<td>Complex numbers.</td>
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<td></td>
<td>Calculus for functions of one variable with applications.</td>
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<td></td>
<td>Simple Mathematical models in engineering.</td>
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<tr>
<td>Lecture notes</td>
<td>Die Vorlesung folgt weitgehend</td>
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<tr>
<td>401-0141-00L</td>
<td>Linear Algebra and Numerical Analysis</td>
<td>O</td>
<td>5 credits</td>
<td>3+1U</td>
<td>P. Grohs</td>
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<tr>
<td>Abstract</td>
<td>Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.</td>
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<tr>
<td>Objective</td>
<td>To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB.</td>
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<tr>
<td>Content</td>
<td>1. Linear systems of equations</td>
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<td></td>
<td>2. Vector and matrix calculus</td>
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<td>3. Subspaces and bases</td>
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<td>4. The Euclidean space Rn</td>
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<td>5. Numerical linear algebra with MATLAB</td>
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<td>6. Linear mappings (optional)</td>
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<td>7. Diagonalization (eigenproblems)</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture Slides will be provided for Download.</td>
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<tr>
<td>Literature</td>
<td>K. Nipp, D. Stoffer, Lineare Algebra, VdF Hochschulverlag ETH</td>
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<tr>
<td>252-0845-00L</td>
<td>Computer Science I</td>
<td>O</td>
<td>5 credits</td>
<td>2+2U</td>
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<td>Abstract</td>
<td>The course covers the basic concepts of computer programming.</td>
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<td>Objective</td>
<td>Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.</td>
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<tr>
<td>101-0031-01L</td>
<td>Systems Engineering</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>B. T. Adey, C. Richmond</td>
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<tr>
<td>Abstract</td>
<td>An introduction to system development, analysis and optimization, and decision making, with focus on linear programming, networks, formal methods and economic analysis.</td>
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<tr>
<td>Objective</td>
<td>- to gain competency in methods used to plan and analyse systems</td>
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<td></td>
<td>- to gain the ability to formulate, analyse and solve complex problems</td>
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<td>- to gain competency in the methods used for the evaluation of multiple solutions</td>
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<tr>
<td>Content</td>
<td>- Introduction</td>
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<tr>
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<td>- System development</td>
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<td>- System analysis</td>
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<td>- Networks</td>
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<td>- Decision theory</td>
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<td>- Economic analysis</td>
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<td></td>
<td>- Cost-benefit analysis</td>
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<tr>
<td>Lecture notes</td>
<td>Script and transparencies as well as additional material via Moodle.</td>
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<tr>
<td>101-0031-02L</td>
<td>Business Administration</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>J.P. Chardonnens</td>
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<tr>
<td>Abstract</td>
<td>Remark: Students BSc Civil Engineering (StR2014) are not allowed to assign to 101-0031-02, but have to assign 101-0031-04 in spring semester (2. Sem.).</td>
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<tr>
<td>Objective</td>
<td>Introduction to business administration</td>
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<td></td>
<td>Principles of accounting and financial management</td>
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<td></td>
<td>Costing systems by corporations</td>
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<td>Financial planning and capital budgeting of projects</td>
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<td>Prepare and analyze the financial statements of organizations</td>
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<td>Understand the major costing systems</td>
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<td>Perform some product calculations</td>
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<td>Establish budget and determine profitability of investment</td>
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</tbody>
</table>
Biology III: Essentials of Ecology

Abstract
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

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

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

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

Literature
### 103-0214-00L Cartography I

**Objective:**
Acquire basic knowhow about communication with spatial information by using plans and maps, about the most important design rules and production methods for map graphics.

**Content:**
Definitions "map" and "cartography", map types, current tasks and situation of cartography, map history, spatial reference systems, map projections, map conception and workflow planning, map design, analog and digital map production technology, prepress technology, printing technology, topographic maps, map critics.

**Lecture notes**
Will be distributed module by module

**Literature**

**Prerequisites / notice**
Further information at http://www.karto.ethz.ch

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### 103-0313-00L Planning I

**Objective:**
To follow shortly; please note the German description.

**Content:**
Einleitung - Was ist Raumplanung (Begriffe)
Die Raumplanung als staatliche Aufgabe - Raumordnungspolitik
Instrumente der Raumplanung (Richtplanung, Nutzungsplanung)
Problemlosungsverfahren in der Raumplanung - systemtechnisches Vorgehen
Das schweizerische Raumordnungskonzept
Der Schwerpunkt der Vorlesung liegt auf der Erläuterung der Raumplanung als Problemlosungsverfahren. Das dabei vermittelte theoretische Wissen wird direkt an einer konkreten, praxisorientierten Übungsaufgabe umgesetzt.

**Lecture notes**
Prof. Dr. W.A. Schmid et al. (2006, Stand 2011): Raumplanung GZ - Eine Einführung für Ingenieurstudierende. IRL-Institut, ETHZ

**Literature**
- Handouts of the lectures
- Exercise material
- Download: http://www.irl.ethz.ch/plus/education

- DISP (journal of the NSL-Network City and Landscape, ETHZ)
- Umweltverträglichkeitsprüfung, vdf, Zürich 1995

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### Examination Block 2

#### 103-0115-00L Geodetic Metrology II

**Abstract**
Advanced topics in geodetic metrology with focus on instrumental and methodic aspects for applications with higher accuracy demands.

**Objective**
The students acquire enhanced knowledge regarding the operating mode, the application and the limitations of modern geodetic standard instruments. They will be able to properly select, test and apply these instruments for geodetic tasks with higher accuracy requirements. They will get acquainted with the typical workflow from the preparation of the field works to the digital or plotted plan. Finally, the students will be introduced to specific geodetic tasks related to construction and civil engineering.

**Content**
- The geomatics workflow
- Propagation of light in the atmosphere
- The modern total station
- Terrestrial Laserscanning
- Digital levels
- Field tests
- Traverses
- Trigonometric leveling
- Precision leveling
- Route planning and transition curves
- Earthworks: Area and cubature

**Lecture notes**
The slides and documents for enhanced study and further reading will be provided online.

**Literature**

---

#### 103-0233-01L GIS I

**Abstract**
This course provides basic knowledge on parameter estimation and data processing. The necessary mathematical and statistical methods are developed and applied to actual examples in geomatics.

**Objective**
The students are capable of analysing measurements with appropriate methods. They can optimally extract model parameters from real measurements and are able to analyse and to retrieve additional information from time series. They understand the underlying algorithms of different geodetic analysis tools and processing methods.

**Content**
Mathematical modeling of engineering problems, general adjustment, minimization principles, propagation of variances, uncertainty of measurements, dealing with heterogeneous measurement types, linear/non linear regression, autocorrelation and colocation

**Lecture notes**
Parameter estimation and Adjustment

**Prerequisites / notice**
Linear Algebra, Statistics

---

### Examination Block 2
### Examination Block 3

*In place of the German course 851-0703-03L Introduction to Law for Civil Engineering students can take the French course 851-0709-00L Droit civil.*

#### Number

<table>
<thead>
<tr>
<th>851-0703-03L</th>
<th>Introduction to Law for Civil Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>2 credits</td>
</tr>
<tr>
<td>2V</td>
<td></td>
</tr>
<tr>
<td>G. Hertig</td>
<td></td>
</tr>
</tbody>
</table>

#### Abstract

This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

#### Objective

Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

#### Literature

- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève
- Nef, Urs Ch.: Le droit des obligations à l’usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève

#### Prerequisites / notice

- The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.

### 5. Semester

#### Compulsory Courses 5. Semester

#### Examination Block 4

<table>
<thead>
<tr>
<th>103-0126-00L</th>
<th>Geodetic Reference Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>3 credits</td>
</tr>
<tr>
<td>2G</td>
<td></td>
</tr>
<tr>
<td>M. Meindl</td>
<td></td>
</tr>
</tbody>
</table>

#### Abstract

Fundamentals of geoinformation technologies: spatial data modeling, metrics & topology, vector and raster data, thematic data, spatial queries and analysis, spatial databases; labs with GIS software

#### Objective

Knowing the fundamentals of geoinformation technologies for the realization, application and operation of geographic information systems in engineering projects.

#### Content

- Einführung GIS & GiScience
- Konzeptionelles Modell & Datenschema
- Vektorgeometrie & Topologie
- Rastergeometrie und -algebra
- Thematische Daten
- Räumliche Abfragen & Analysen
- Geodatenbanken

#### Literature


Overview over the entire spectrum of Higher Geodesy

Actual methods of Higher Geodesy. Basics of Shape of the Earth: Geoid determination and deflection of the vertical. Introduction into the most important topics: Satellite Geodesy (GPS) and Navigation; Physical Geodesy and gravity field of the Earth; Astronomical Geodesy and Positioning; Mathematical Geodesy and basics of Geodynamics. Reference systems and applications in National and Global Geomatics.


Course notes will be provided in German. Slides are made available some days before each lecture.

Lecture notes

Download: http://www.irl.ethz.ch/plus/education

References in the lecture notes

Download: http://www.irl.ethz.ch/plus/education

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

First part: Spatial planning on the Commune level with focus on the special land use management
Second part: land re-allocation as an instrument of spatial planning; specific explanations for land re-allocations in rural areas and in construction zones.
Third part: land marketing; the view of investors.

PART 1: Spatial Planning and Special Land Use Management
- Overview about Spatial Planning on the commune level
- workflows and planning methods on the commune level
- comprehension of the public
- getting knowledge of the special land use management

PART 2: Methods of Land Re-Allocation
- Intensions and principles of land re-allocation
- implementation of the land re-allocation
- land re-allocation in construction zones
- amelioration

PART 3: Agricultural Planning

No remarks.

Yes

The transparencies will be available for download from the website at least one week before each class.

Copies of all necessary documents will be distributed at appropriate times.

General introduction to the development, the life cycle and the characteristics of projects. Introduction to, and experience with, the methods and tools to help with the preparation, evaluation, organisation, planning, controlling and completion of projects.

To introduce the methods and tools of project management. To impart knowledge in the areas of project organisation and structure, project planning, resource management, project controlling and on team leadership and team work.

- From strategic planning to implementation (Project phases, goals, constraints, and feasibility)
- Project leadership (Leadership, Teams)
- Project organization (Structure)
- Project planning (Schedule, cost and resource planning)
- Risk and Quality Management
- Project completion

Course notes will be provided in German. Slides are made available some days before each lecture.

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

Elective Blocks

Elective Block: GIS, Photogrammetry and Cartography

Thematic Cartography

Thematic map types (focus on quantitative information), analysis of themes and application, base maps, generalisation

Knowing of most important thematic map types.

Ability to design adequate thematic maps from statistical data.
### Elective Block: Geodesy and Geodetic Metrology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0125-00L</td>
<td>Geodetic Networks and Parameter Estimation</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>S. Guillaume</td>
</tr>
</tbody>
</table>

**Abstract**
This course provides knowledge for parameter estimation and data analysis in geodetic networks. The necessary mathematical and statistical methods are explained and applied by means of concrete examples.

**Objective**
The students are able to plan, pre-analyse and perform analysis of geodetic networks for practical problems. They are able to understand and develop geodetic software.

**Content**
Refreshment of statistical and probabilistic basics (simulations with random number generators, correlated random noise, empirical density and distribution functions, hypothesis tests), 2D + 1 and 3D terrestrial and satellite based observation equations, coordinate transformation (Helmert, affine), geodetic datum problem (free networks, stochastically structured, quality indicators of geodetic networks (global and local accuracy resp. reliability), robust estimators (M-estimators, L-estimators, LMS-estimator), network optimization (manual, semi-automatic), deformation measurements (congruence test, S-transformations).

**Prerequisites / notice**
Linear algebra, statistic and probability, geoprocessing and parameter estimation, geodetic metrology

### Elective Block: Spatial Development and Environmental Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0315-03L</td>
<td>Planning III</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Grét-Regamey, U. Wissen Hayek</td>
</tr>
</tbody>
</table>

**Abstract**

1. Einführung in die Fernerkundung von Luft- und Weltraum gestützten Systemen
2. Einführung in das Elektromagnetische Spektrum
3. Einführung in optische Systeme (optisch und hyperspektral)
4. Einführung in Mikrowellen-Technik (aktiv und passiv)
5. Einführung in atmosphärische Systeme (meteo und chemisch)
6. Einführung in die Techniken und Methoden zur Bestimmung von Umweltparametern
7. Einführung in die Anwendungen zur Bestimmung von Umweltparametern in der Hydrologie, Glaziologie, Forst und Landwirtschaft, Geologie und Topographie

**Literature**
Foliens zu jeden Vorlesungsblock werden zur Verfügung gestellt.

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**Further information at** [http://www.karto.ethz.ch](http://www.karto.ethz.ch)
### Electives Block: Transport

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0647-00L</td>
<td>Introduction to Mathematical Optimization</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>R. Zenklusen</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to basic techniques and problems of mathematical optimization.

**Objective**

The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

**Content**

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

**Lecture notes / notice**

Information about relevant literature will be given in the lecture.

**Prerequisites / notice**

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

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Filippi</td>
</tr>
</tbody>
</table>

**Abstract**

The course introduces basic principles, problems and approaches of microeconomics.

**Objective**

The course includes the following main topics:
- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

**Lecture notes**

Lecture notes, exercises and reference material can be downloaded from Moodle.

**Literature**


The book can also be used for the course "Principles of Macroeconomics" (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:


**Complementary**


### Compulsory Electives in Humanities, Social and Political Sciences

- Recommended GESS compulsory elective courses (Type B) for D-BAUG.

- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

- see GESS Compulsory Electives: Language Courses ETH/UZH

### Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

#### List of Electives Recommended by the Degree Programme

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-1425-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W+</td>
<td>6</td>
<td>2V+2U+1A</td>
<td>B. Gärtner, M. Hoffmann, E. Welzl</td>
</tr>
</tbody>
</table>

**Abstract**

Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)

**Objective**

The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains.

In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.

**Content**

Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in R^d, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.

**Lecture notes**

yes

**Literature**


**Prerequisites / notice**

Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.

**Outlook**

In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

### Electives ETH Zurich

Data: 06.12.2018 13:04

Autumn Semester 2015

Page 654 of 1432
### Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0006-00L</td>
<td>Bachelor's Thesis</td>
<td>O</td>
<td>10 credits</td>
<td>20D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

**Abstract**

The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

**Objective**

Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

**Content**

The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

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**Geomatic Engineering and Planning Bachelor - Key for Type**

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
## Major in Engineering Geodesy and Photogrammetry

### Course List

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0287-00L</td>
<td>Image Interpretation</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>K. Schindler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to interactive, semi-automatic and automatic methods for image interpretation; methodological aspects of computer-assisted remote sensing, including semantic image classification and segmentation; detection and extraction of individual objects; estimation of physical parameters.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Understanding the tasks, problems, and applications of image interpretation; basic introduction of computational methods for image-based classification and parameter estimation (clustering, classification, regression), with focus on remote sensing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Image (and point-cloud) interpretation tasks: semantic classification (e.g. land-cover mapping), physical parameter estimation (e.g. forest biomass), object extraction (e.g. roads, buildings), visual sensor assistance; image coding and features; probabilistic inference, generative and discriminative models; clustering and segmentation; continuous parameter estimation, regression; classification and labeling; atmospheric influences in satellite remote sensing;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites</td>
<td>basics of probability theory and statistics; basics of image processing; elementary programming skills (Matlab);</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

| 103-0137-00L  | Engineering Geodesy                        | O    | 4    | 3G    | A. Wieser, M. Frukacz   |
| Abstract      | Introduction to Engineering Geodesy: methods, instruments, and applications. |
| Objective     | The students will be introduced to the methods, instruments and applications in Engineering Geodesy with a focus on end-to-end quality assessment, sensor and multi-sensor-systems, setting out, and monitoring of engineering objects. They will be able to acquire enhanced knowledge and fundamental competences in high-precision angle, distance and height measurements. They will be introduced to aspects of interdisciplinary work in particular related to construction processes and civil engineering. |
| Content       | - Introduction: Definition, methods, and tasks |
|               | - Planning and realizing geodetic networks |
|               | - High precision distance, angle and height measurements |
|               | - Sensors and multi-sensor-systems |
|               | - Calibration and testing |
|               | - Engineering Geodesy in construction above and below ground |
|               | - Tunnel surveying |
|               | - Building Information Modeling (BIM) |
|               | - Deformation monitoring: Models, methods, and applications |
| Prerequisites | Fundamental knowledge in geodetic metrology (applied geodesy), physical geodesy, reference systems, GNSS and parameter estimation is required for this course. This knowledge can for instance been acquired within the appropriate courses of the bachelor studies in Geomatics and Planning. |

| 103-0267-01L  | Photogrammetry and 3D Vision Lab           | W    | 3    | 2P    | K. Schindler, J. D. Wegner |
| Abstract      | The course deals with selected topics of close-range photogrammetry and geometric computer vision, including wide-baseline image matching and reconstruction, dense surface reconstruction, panorama stitching and image indexing; emphasis is put on practical project work. |
| Objective     | The aim of the course is to get to know the methods and practice of close-range photogrammetric reconstruction, and an in-depth understanding of selected topics in modern close-range photogrammetry and computer vision. |
| Content       | This course builds in part on the courses "Photogrammetrie", "Bildverarbeitung" and "Photogrammetrie II" from the Bachelor program. It focusses on the particular challenges of automated close-range photogrammetry. |
| Lecture notes | Recommended textbooks: |
| Literature    | - T. Luhmann. Nahbereichsphotogrammetrie (also available in English) |
|               | - R. Hartley and A. Zisserman. Multi-view geometry in computer vision |
|               | - R. Szeliski. Computer Vision |
| Prerequisites | A recommended prerequisite for taking this course are the Bachelor courses "Photogrammetrie", "Bildverarbeitung" and "Photogrammetrie II". If you have not passed them, please contact the main lecturer of the course before enrolling. The course will include both practical work with commercial software, and programming in Matlab. |

| 103-0767-00L  | Engineering Geodesy Lab                    | W    | 4    | 3P    | A. Wieser, S. Conzett   |
| Abstract      | Development of concepts and solutions for challenging tasks in Engineering Geodesy using real-world examples |
| Objective     | The students learn to develop, assess and realize concepts and solutions for real-world problems in Engineering Geodesy. They advance the knowledge and skills which they have acquired in relation with geodetic metrology, engineering geodesy. They establish links between these subjects. Particular attention is paid to the selection of appropriate sensors and measurement systems, selection of appropriate measurement and data processing methods, end-to-end quality control, fulfillment of non-technical criteria, and to the documentation of the work. |
| Content       | Actual real-world problems are chosen for this lab depending on the number, background and experience of the students. If possible the problems are chosen in connection with current research projects within the Geosensors and Engineering Geodesy Group. Examples of such problems are: |
|               | - high-precision transfer of coordinates and orientation through a long vertical shaft |
|               | - monitoring of the deformation of an ice-panle |
|               | - development of a 2D-machine-control-and guidance system |
|               | - bridge vibration monitoring |
| Lecture notes | Publications and documents are made available as needed depending on the selected tasks. |
Cadastral Systems

Learn to solve engineering problems with modern methods of parameter estimation in a real-world scenario.

Objective

The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed.

Handouts for each topic will be provided

Prerequisites / notice

Successful participation in the lab requires knowledge and experiences conveyed within the related course "Engineering Geodesy". Students who have not already passed that course and who are not participating in that course will only be admitted to the lab after discussion with the instructors.

If the timetable of the participants allows it, the 3-hourly lab units will partially be combined to individual full-time units.

Prerequisites:


103-0787-00L Project Parameter Estimation

W 3 credits 2P A. Wieser

Abstract

Solving engineering problems with modern methods of parameter estimation for network adjustment in a real-world scenario; choosing adequate mathematical models, suitable data-flow and performing software.

Content

Analysis of the given problem, selection of effective mathematical models, use of appropriate software.

Lecture notes

Assignment of tasks; selected documentation

Prerequisites / notice

- Prerequisite: Statistics and Probability Theory, Geoprocessing and Parameter estimation, Geodetic Reference Systems and Networks

102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications

W 3 credits 2G I. Hajnsek

Abstract

The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

Objective

The course should provide an understanding of SAR techniques and the use of the imaging tools for biogeophysical parameter estimation.

At the end of the course the student has the understanding of:

1. SAR basics and principles
2. SAR polarimetry
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

Content

The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:

1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

Lecture notes

First readings for the course:


Complete literature listing will be prepared during the course.

Prerequisites / notice

- Prerequisite: Statistics and Probability Theory, Geoprocessing and Parameter estimation, Geodetic Reference Systems and Networks

851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law

W 2 credits 2V M. Huser

Abstract

Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Objective

Overview of the legal norms of land registry and surveying law.

Content

Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, reform of official surveying and topographical data, liability of the geometer. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

Literature

- Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Dieter Zobl, Grundbuchrecht, Zürich 1999
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

Prerequisites / notice

Requirements: Property Law (12-722)

103-0687-00L Cadastral Systems

W 2 credits 2G D. M. Steudler

Abstract

Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs).

Objective

The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed.

Handouts for each topic will be provided

Prerequisites / notice

If the timetable of the participants allows it, the 3-hourly lab units will partially be combined to individual full-time units.

Literature


Prerequisites / notice

- Prerequisite: Statistics and Probability Theory, Geoprocessing and Parameter estimation, Geodetic Reference Systems and Networks

- Meinrad Huser, Datenschutz bei Geodaten
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

Prerequisites / notice

- Prerequisite: Statistics and Probability Theory, Geoprocessing and Parameter estimation, Geodetic Reference Systems and Networks

- Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Dieter Zobl, Grundbuchrecht, Zürich 1999
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

Prerequisites / notice

Requirements: Property Law (12-722)
### Content

- Origins and purposes of cadastral systems
- Importance of documentation
- Basic concepts of cadastral systems (real estate, legal basis, conceptual principles, property-ownership, property types)
- Swiss cadastral system:
  - legal basis
  - organization
  - technical elements
  - methods of data acquisition and maintenance
  - profession
  - quality assurance
- Digital revolution, access to data
- Benchmarking and evaluation of cadastral systems
- International trends, developments and initiatives

### Lecture notes


### Literature


see also: [http://www.geo21.ch/ethz/](http://www.geo21.ch/ethz/)

---

### Major in Space Geodesy and Navigation

#### Number

<table>
<thead>
<tr>
<th>103-0187-01L</th>
<th>103-0657-01L</th>
<th>103-0627-00L</th>
<th>103-0582-00L</th>
</tr>
</thead>
</table>

#### Title

- Space Geodesy
- Signal Processing, Modeling, Inversion
- Astro and Gravity Lab
- Project Parameter Estimation

#### Type

W = Winter Semester, O = Autumn Semester

#### ECTS

- 4 credits
- 3 credits
- 5 credits
- 3 credits

#### Hours

- 3G
- 3V+1U+1A
- 4P

#### Lecturers

- M. Rothacher
- A. Geiger
- C. Hollenstein
- A. Wieser

---

### Courses corresponding to:

- Analysis I-II, Geoprocessing and Parameterestimation, Linear Algebra I
- Additional literature will be distributed during lectures

### Prerequisites

- It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

Objective
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of:
1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

Content
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

Lecture notes
Handouts for each topic will be provided

Literature
First readings for the course:

Complete literature listing will be provided during the course.

Prerequisites / notice
This course in combination with 102-0627-00-G: Applied Radar Remote Sensing for Environmental Parameter Estimation is providing a profound basis for independent data analysis. It is recommended to take both courses together.

103-0687-00L Cadastral Systems

Abstract
Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs).

Objective
The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed.

Content
Origins and purposes of cadastral systems
Importance of documentation
Basic concepts of cadastral systems (real estate, legal basis, conceptual principles, property-ownership, property types)
Swiss cadastral system:
- legal basis
- organization
- technical elements
- methods of data acquisition and maintenance
- profession
- quality assurance
Digital revolution, access to data
Benchmarking and evaluation of cadastral systems
International trends, developments and initiatives

Lecture notes
see: http://www.geo21.ch/ethz/

Literature

see also: http://www.geo21.ch/ethz/

851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law

Abstract
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

Objective
Overview of the legal norms of land registry and surveying law.

Content
Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geometer. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

Lecture notes
Abgegebene Unterlagen: Skript in digitaler Form

Literature
- Meinrad Huser, Geo-Informationssysteme, Zürich 1999
- Meinrad Huser, Grundbuchrecht, Zürich 1999
- Meinrad Huser, Darstellung des Fernsprechrechtlichen Rechts, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

Prerequisites / notice
Requirements: Property Law (12-722)
Objective
a) Students are introduced to various geodetic techniques and to their most famous applications in Earth Sciences;
b) Students are able to independently conceptualize 1) the inter seismic strain accumulation for an earthquake and 2) inflation of a spherical reservoir (i.e. magma chamber of a volcano) or 3) water level change within aquifer. c) Students are then introduced to news techniques linking seismology and geodesy.

Content
1. Plate Tectonics before Space Geodesy.
3. The seismic cycle monitoring (Moment release, seismology, Stress transfer)
4. Space geodetic techniques (VBLI, gravity, etc.)
5. Presentation of GPS and Applications 1 (positioning, rigid plate motions)
6. GPS networks in the world. Development of tectonic geodesy and Applications 2 (Practical on inter-seismic deformation)
7. Presentation of InSAR, pSAR, etc. Applications to earthquake. Post-seismic deformation.
8. GPS and deformation related to volcanoes (Practical on Mogi source)
9. GPS, Stress, and Plate motion.
10. InSAR applied to subsidence and small deformation.
11. Troposphere sounding. Accuracies of GPS and InSAR.
12. GPS and geodynamics
13. Future of GPS. Future of InSAR.
14. GPS and normal modes?

Lecture notes
Slides. Script in English is planned. PDF of articles cited.

Geology and Geophysics equivalent to Bachelor program at ETH
Math of Bachelor program at ETH

Literature
See webpage

Prerequisites / notice
Pre-Requisite:
Of advantage:
Higher Geodesy Basics; Physical Geodesy and Geodynamics I; Seismotectonics

The grading is based on participation, homework sets, and a final oral presentation. There is no final exam.

►► Major in GIS and Cartography

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0227-00L</td>
<td>Cartography III</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>L. Hurni</td>
</tr>
</tbody>
</table>

Abstract
Basic methods, technologies, scripting, and systems for interactive web mapping projects and in the internet cartography

Objective
Gain knowledge about basic methods, technologies, scripting, and systems for interactive web mapping projects. Assessment of existing products regarding production methods. Definition of useful methods for Web-based map projects.

Content
- Web mapping
- Web Map Services (WMS)
- User Interface design
- Symbolisation
- Programming
- Java Script
- Debugging
- Map production using GIS data
- 3D-applications in cartography

Lecture notes
Own script and instructions will be distributed.

Literature

Prerequisites / notice
Prerequisites: Kartografie I; Thematische Kartografie

103-0237-00L GIS III  O    5    3G    P. Kiefer, S. Scheider

Abstract
The course deals with advanced topics in GIS; GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services; technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS.

Objective
Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services.

Lecture notes
no script

Literature

103-0747-00L Cartography Lab W    6    13A   L. Hurni

Abstract
Independent practical work in cartography

Objective
Independent practical work in cartography

Content
Choice of theme upon individual agreement

Prerequisites / notice
German or English

103-0687-00L Cadastral Systems W    2    2G    D. M. Steudler

Abstract
Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed.

Objective
The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed.
### Content
- Origins and purposes of cadastral systems
- Importance of documentation
- Basic concepts of cadastral systems (real estate, legal basis, conceptual principles, property-ownership, property types)
- Swiss cadastral system:
  - legal basis
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  - technical elements
  - methods of data acquisition and maintenance
  - profession
  - quality assurance
- Digital revolution, access to data
- Benchmarking and evaluation of cadastral systems
- International trends, developments and initiatives

### Lecture notes
- Abgegebene Unterlagen: Skript in digitaler Form

### Literature
- see also: http://www.geo21.ch/ethz/

### 851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law
- **Abstract**
  - Particularly suitable for students of D-ARCH, D-BAUG, D-USYS
  - Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).
- **Objective**
  - Overview of the legal norms of land registry and surveying law.
- **Content**
  - Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geom-eter. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.
- **Lecture notes**
  - Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
  - Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
  - Dieter Zobl, Grundbuchrecht, Zürich 1999
  - Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
  - Meinrad Huser, Datenschutz bei Geodaten
- **Prerequisites / notice**
  - Requirements: Property Law (12-722)
  - Condition for participation: Successful bachelor lecture GIS II

### 103-0258-00L Interoperability of GIS
- **Abstract**
  - Content: Transform back and forth (geo-)data with same content but different structure.
  - Tools: Conceptual schema languages UML and INTERLIS, formats ITF, XML, tools ILI-Checker and awk, and for the semantic transformation UMLT and FME.
- **Objective**
  - Explain and apply the model-driven approach based on standards
  - Know and use interoperability types
  - Know transfer formats and reformat with 1:1 processors
  - Explain object-oriented modelling (with graphic and text)
  - Know and use communication technologies and OGC Web services
  - UML, EBNF, INTERLIS, ITF, XML, awk, FME
  - Know and apply appropriate software tools
- **Content**
  - Semantic interoperability of GIS is in the main part of this lecture and means to transform back and forth (geo-) data with same content but different structure. The reduction of the necessary programming amount to a modest minimum is provided by the system-independent model-driven approach. Its elements reality selection, conceptual modelling, flexible standard formats, 1:1 processors and semantic transformation are presented and used. As generally useful tools are introduced and applied the conceptual schema languages UML and INTERLIS, the flexible transfer formats ITF, XML the ILI-Checker, the efficient reformating tool awk and for the semantic transformation UMLT and FME.
- **Prerequisites / notice**
  - Condition for participation: Successful bachelor lecture GIS II

### 103-0778-00L GIS and Geoinformatics Lab
- **Abstract**
  - Independent study project with (mobile) geoinformation technologies. Design and programm and mobile app and contribute it to the “Zurich Open data” portal.
  - See: https://www.stadt-zuerich.ch/portal/de/index/ogd/daten.html
  - Learn how to work with (mobile) geoinformation technologies (including application design and programming) and make a contribution to the Zurich Open Data community. A possible topic is given below but students may choose their own topic(s). The only requirement is that the application makes use of the Zurich open dataset.
- **Objective**
  - Know and apply appropriate software tools
  - UML, EBNF, INTERLIS, ITF, XML, awk, FME
  - Know transfer formats and reformat with 1:1 processors
  - Know and use communication technologies and OGC Web services
- **Content**
  - A possible topic is the design and programming of a bicycle information system that provides the following data sets as a service:
    - Routing-Service
    - Real-time data "Rent-a-bike"
    - Bicycle Pump Station
    - Bicycle parking spots
- **Literature**
  - All data is freely available and part of the Zurich Open Data.
  - See: https://www.stadt-zuerich.ch/portal/de/index/ogd.html
  - https://www.stadt-zuerich.ch/portal/de/index/ogd/daten.html
The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to use R appropriately in landscape planning.

**Objective**

The aims of this course are:

1. To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.
2. To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.
3. To show the importance of ecosystem services.
4. To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).
5. To identify and measure the characteristics of landscape.
6. Learn how to use the instrument of GIS appropriately in landscape planning.

**Content**

In this course, the following topics are discussed:

- Definition of the concept of landscape
- Landscape change
- Landscape planning
- Methods, instruments and aims of landscape planning (politics)
- Socio-political questions of the future
- Environmental systems, IUCN Red List, ecological connectivity
- Urban landscape services
- Practice of landscape planning
- Use of GIS in landscape planning

**Lecture notes**

No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

**Prerequisites / notice**

The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (exercises)). An combination of courses is recommended.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>103-0347-00L</td>
<td>Landscape Planning and Environmental Systems n</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Grêt-Regamey</td>
</tr>
<tr>
<td></td>
<td>Only for master students, otherwise a special permission by the lecturers is required.</td>
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</table>

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>103-0337-00L</td>
<td>Site and Project Development</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Nussbaumer</td>
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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>103-0337-00L</td>
<td>Introduction to the Data Analysis Software R</td>
<td>W</td>
<td>1 credit</td>
<td>1G</td>
<td>A. Grêt-Regamey, M. J. Van Strien</td>
</tr>
</tbody>
</table>

R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

**Abstract**

The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester exercise covers a specific major project and serves as the semester grade (project report and presentation).

**Objective**

Objectives of the lecture are:

1. Get knowledge of comprehensive and multifunctional large-scale projects and their problem areas
2. Get deepened knowledge in selected fields (site analysis, market analysis, project development, cooperative planning, participation processes)
3. Practical orientation, insight into occupational fields
4. Independent acquisition and acquisition of theoretical knowledge

**Content**

The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. Technical presentations, lectured by scientific staff of the division of Planning of Landscape and Urban Systems PLUS as well as well guest referees treat different subjects.

The subjects are:

- Site and market analysis
- Real estate development
- Project development from the perspective of project developers and investors
- Parking and transportation models
- Cooperative planning, participation processes, mediation

The theory is discussed and illustrated at case studies and exercises. Specific large-scale projects that are currently in the development phase will be discussed, for example the area Sihl- Manegg in Zurich (GreenCity) or the area Alter Pilatusmarkt (Niedfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

**Lecture notes**

- Handouts of the lectures
- Extracts from relevant scientific articles and theory literature
- Exercise material

Download: http://www.irl.ethz.ch/plus/education
**103-0317-00L** Sustainable Spatial Development I

*Objective*
Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation.

*Content*
- Knowledge of methods and algorithms commonly used in transport planning
- Inner development
- Integrated spatial and infrastructure development
- Cross-border issues in spatial development

*Literature*

---

**103-0417-02L** Theory and Methodology of Spatial Planning

*Objective*
The participants know the interdependencies between the assessment of a situation, decision making, knowledge and language. They know the nature of a decision dilemma und maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding acteur. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.

*Content*
- Tasks of Spatial Planning and development
- Issues of local and supra-local interest
- Recurring spatial changes, impacts and key figures
- Formal and informal instruments and procedures in spatial planning
- Spatial Design - Ideas about the future
- Reasoning and assessing the situation in spatial planning
- Spatial planning as a sequence of decisions and interventions
- Process and procedures management
- Focus issues - Inner development before external development
- Focus issues - Cross-border tasks
- Focus Issues - Integrated spatial and infrastructure development

---

**101-0427-01L** System and Network Planning

*Objective*
Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them.

*Content*
1. Fundamentals of system and network planning: Mobility and transport systems; public transport systems; customer needs versus service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile.
2. System and network planning: generic planning process; demarcation, analysis of the situation, setting of targets; design of public transport services; evaluation and optimization; system planning. (3) Public transport services: long distance service offers; suburban and urban service offers; regional and local service offers; access to public transport and the last mile.

*Literature*
A script in German will be provided for the course. The slides are made available.

---

**101-0417-00L** Transport Planning Methods

*Objective*
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems.

*Content*
- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

*Literature*

---

**103-0347-01L** Landscape Planning and Environmental Systems

*Objective*
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

*Content*
The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

*Literature*

---

**103-0317-00L** Sustainable Spatial Development I

*Objective*
The course will be held in English and no prior knowledge on R is required.

*Content*
- Knowledge of methods and algorithms commonly used in transport planning
- Inner development
- Integrated spatial and infrastructure development
- Cross-border issues in spatial development

*Literature*
The course content of the lecture Landscape Planning and Environmental Systems (103-0347-00 V) will be illustrated.

**Abstract**

To show the importance of ecosystem services.

**Objective**

Analysis and assessment of the complex interactions between landscape elements.

**Content**

- Environmental systems, IUCN Red List, ecological connectivity
- Calculating urban landscape services
- Practice of landscape planning
- Use of GIS in landscape planning
- Modelling
- Landscape analysis
- Landscape metrics

**Lecture notes**

No script. The documentation, consisting of presentation slides are partly handed out and are pro-vided for download on the PLUS website.

**Literature**

Will be named in the lecture.

### Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

#### List of Electives Recommended by the Degree Programme

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0439-00L</td>
<td>Introduction to Economic Policy - A Case Study Approach with Cost Benefit Analysis in Transport</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>K. W. Axhausen, R. Schubert</td>
</tr>
</tbody>
</table>

**Abstract**

The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.

**Objective**

Familiarity with the essential methods of project appraisal

**Content**

Cost-Benefit-Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety

**Lecture notes**

Handouts

**Literature**


<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>101-0449-00L</td>
<td>Management, Marketing, Quality</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>U. A. Weidmann</td>
</tr>
</tbody>
</table>

**Abstract**

Transport and administrative policy, international and national regulation, business management of public transport companies, marketing, advertising and pricing; quality management

**Objective**

Comprehension of the transport and administrative policy as well as of the regulation of public transport companies. To develop a full understanding of the three important public transport system operations management processes: (1) Business management; (2) Marketing; (3) Quality control. The course will teach essential working techniques in each of these processes.

**Content**

(1) Transport and administrative policy: Goals of the state related to public transports, governmental activities in public transport, regulation.
(2) Business management in public transport enterprises: goals of public transport companies, goals of the business management; management of public transport on the different management levels, business organization. (3) Marketing, advertising and pricing: Fundamentals and goals; marketing strategies and concepts in public transports; marketing tools; putting marketing into action. (4) Quality control: Quality in transport systems; goals of quality management; structuring quality control measures; collecting quality data in an operating service; use of quality control systems for service optimization.

**Lecture notes**

Course notes will be provided in German. Slides will be made available.

**Literature**

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

**Prerequisites / notice**

Lectures System and Network Planning as well as Systems Dimensioning and Capacity recommended.

### Electives ETH Zurich

Course Catalogue of ETH Zurich

### Seminar Work (ONLY for Programme Regulations 2013)

<table>
<thead>
<tr>
<th>Number</th>
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</table>

**Abstract**

Introduction to general scientific working methods and skills in the core fields of geomatics. It includes a literature study, a review of one of the articles, a presentation and a report about the literature study.

**Objective**

Learn how to search for literature, how to write a scientific report, how to present scientific results, and how to critically read and review a scientific article

**Content**

A list of themes for the literature study are made avalable at the beginning of the semester. A theme can be selected based on a moodle.

**Prerequisites / notice**

Agreement with one of the responsible Professors is necessary

### Interdisciplinary Project Work (ONLY for Programme Regulations 2013)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0928-02L</td>
<td>Interdisciplinary Project</td>
<td>O</td>
<td>12 credits</td>
<td>24A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Abstract**

Working on a concrete interdisciplinary task in Geomatics

**Objective**

Promote independent, structured and scientific work in an interdisciplinary context; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

**Content**

The project work is supervised by a professor. Students can choose from different subjects and tasks.

The project can be carried out in German upon mutual agreement between supervisor and student.

**Compulsory Electives in Humanities, Social and Political Sciences**

- Recommended GESS compulsory elective courses (Type B) for D-BAUG.
- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses ETH/ÜZH

**Master Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0009-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>24</td>
<td>47D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

**Abstract**

Before starting the Master's thesis, students must have:

a. obtained the Bachelor's degree;

b. fulfilled all specified admission conditions, if any;

c. acquired at least 90 credits in the Master's programme, including 12 credits in the area of the interdisciplinary project.

**Objective**

The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

**Content**

The topics of the Master Thesis are published by the professors. The topic can be set also in consultation between the student and the professor.

**Course Units for Additional Admission Requirements**

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0115-AAL</td>
<td>Geodetic Metrology II</td>
<td>E-</td>
<td>5</td>
<td>4R</td>
<td>A. Wieser</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advanced topics in geodetic metrology with focus on instrumental and methodic aspects for applications with higher accuracy demands.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The students acquire enhanced knowledge regarding the operating mode, the application and the limitations of modern geodetic standard instruments. They will be able to properly select, test and apply these instruments for geodetic tasks with higher accuracy requirements. They will get acquainted with the typical workflow from the preparation of the field works to the digital or plotted plan. Finally, the students will be introduced to specific geodetic tasks related to construction and civil engineering.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lecture notes**

Slides and documents for enhanced study and further reading will be provided online.

**Literature**


| 103-0126-AAL | Geodetic Reference Systems     | E-   | 3    | 3R    | M. Meindl |
|              | Enrolment only for MSc students who need this course as additional admission requirement. |
|              | Fundamentals and theory of geodetic reference systems and frames. Introduction to current international systems as well as to systems for the Swiss national geodetic survey. Provision of fundamental knowledge and theory to get familiar with the applications of geodetic reference systems. Special emphasis will be placed on international global systems as well as on the systems of the Swiss national geodetic survey. |

| 103-0132-AAL | Geodetic Metrology Fundamentals | E-   | 6    | 4R    | A. Wieser |
|              | Enrolment only for MSc students who need this course as additional admission requirement. |
|              | Introduction to the most important sensors, operation and calculation methods of Geodetic Metrology. Getting to know the most important sensors, operation and calculation methods of Geodetic Metrology. |
|              | Overview on the different domains of geodetic metrology Geodetic instruments and sensors Determination of 3D-coordinates with GNSS, total sttaion and levelling Calculation methods of geodetic metrology Survey and staking-out methods |

**Lecture notes**

Slides and additional material used in the associated regular course Geodätische Messtechnik GZ (in German) are provided in electronic form.

**Literature**


**Prerequisites / notice**

The field course is part of this lecture. Practical exercises complete the subjects taught during the semester.

If evidence of equivalent practical experience in surveying cannot be provided by the student, participation in the field course during the respective next available period (i.e. 1 week in the beginning of the summer holidays) is required.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
</table>
Spatial planning is concerned with the foresighted design of the built and un-built environment. Starting points are spatially relevant problems that need to be explored, clarified and solved. The cornerstone of the course is formed by an independent exploration by the student of two Zurich city quarters.

Prerequisites / notice
Requirements: knowledge of physics, linear algebra and analytical geometry, calculus, least-squares adjustment and statistics, basic programming skills.

103-0255-AAL
Geodata Analysis
Enrolment only for MSc students who need this course as additional admission requirement.
Objective
The course deals with advanced methods in spatial data analysis.

Abstract
The course deals with advanced methods in spatial data analysis.

Content
The course deals with advanced methods in spatial data analysis in theory as well as in practical exercises.

Literature

103-0274-AAL
Image Processing
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
The objective of this lecture is to introduce the basic concepts of image formation and explain the basic methods of signal and image processing.

Objective
Understanding core methods and algorithms in image processing and computer vision and the underlying signal processing foundations.

Content
- Image segmentation
- Properties of digital images
- Signal processing/Sampling
- Image enhancement
- Image restoration: Spatial domain
- Image restoration: Fourier domain
- Color/Demosaicing
- Image compression
- Feature extraction
- Texture analysis

Literature
We suggest the following textbooks for further reading:
Rafael C. Gonzalez, Richard E. Woods
Digital Image Processing
ISBN: 013168728X

Rafael C. Gonzalez, Steven L. Eddins, Richard E. Woods:
Digital Image Processing Using MATLAB
Prentice Hall, 2003
ISBN: 0130085197

103-0313-AAL
Planning I
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
The lecture introduce into the main-features of spatial planning. Attended will be the themes planning as a national responsibility, instruments of spatial planning, techniques for problem-solutions in spatial planning and the swiss concept for regional planning.

Objective
- To get to know the interaction between the community and our living space and their resulting conflicts.
- Link theory and practice in spatial planning.
- To get to know instruments and facilities to process problems in spatial planning.

103-0325-AAL
Planning II
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
The lecture imparts methodological and instrumental fundamentals for spatial planning and will be exemplified by exploring two Zurich city quarters.

Objective
Spatial planning is concerned with the foresighted design of the built and un-built environment. Starting points are spatially relevant problems that need to be explored, clarified and solved. The cornerstone of the course is formed by an independent exploration by the student of two Zurich city quarters that involves investigating specific spatially relevant conditions, recognizing regularities and relevant problems.

Content
The self-study course compromises the following readings:
- Lynch, Kevin: «The Image of the City»,
- Alexander, Christopher et al.: «A Pattern Language»,
- Mikoletz, Anne und Pürckhauer, Moritz: «Urban Code», and
- «SIDAIA - Spatial and Infrastructure Development: An Integrated Approach».

The graded semester performance comprises a condensed paper to be written by the student reflecting both the literature read as well as exemplarily applying the knowledge gained from the literature by independently exploring the two city quarters.
<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0023-AAL</td>
<td>Physics</td>
</tr>
<tr>
<td>E- 7 credits</td>
<td>L. Degiorgi</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic topics in classical as well as modern physics, interplay between basic research and applications.</td>
</tr>
<tr>
<td>Content</td>
<td>Electrodynamics, Thermodynamics, Quantum physics, Waves and Oscillations, special relativity</td>
</tr>
<tr>
<td></td>
<td>Hans J. Paus, Physik in Experimenten und Beispielen, Carl Hanser Verlag München Wien (als unterrichtsbegleitendes und ergänzendes Lehrbuch)</td>
</tr>
<tr>
<td>406-0141-AAL</td>
<td>Linear Algebra and Numerical Analysis</td>
</tr>
<tr>
<td>E- 5 credits</td>
<td>P. Grohs</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to Linear Algebra and Numerical Analysis for Engineers. This reading course is based on chapters from the book &quot;Introduction to Linear Algebra&quot; by Gilbert Strang (SIAM 2009), and &quot;A first Course in Numerical Methods&quot; by U. Ascher and C. Greif (SIAM, 2011).</td>
</tr>
<tr>
<td>Objective</td>
<td>To acquire basic knowledge of Linear Algebra and some aspects of related numerical methods and the ability to apply basic algorithms to simple problems.</td>
</tr>
<tr>
<td>Content</td>
<td>* Linear systems of equations: Gaussian elimination, row echelon form, theory about existence and uniqueness of solutions (Strang Ch. 2 and 3.4)</td>
</tr>
<tr>
<td></td>
<td>* Mathematical modelling by linear systems (e.g. networks, trusses) (Strang, parts of Ch. 8)</td>
</tr>
<tr>
<td></td>
<td>* Column space, null space and rank of matrices (Strang 3.2, 3.3)</td>
</tr>
<tr>
<td></td>
<td>* linear combinations, linear (in)dependence, bases, dimension theorem for matrices (Strang 3.5, 3.6)</td>
</tr>
<tr>
<td></td>
<td>* inner product, orthogonality, length in Euclidean space (Strang 4.1, 4.2)</td>
</tr>
<tr>
<td></td>
<td>* Least squares solutions and orthogonalization (Gram-Schmidt and QR) (Strang 4.3, 4.4)</td>
</tr>
<tr>
<td></td>
<td>* Linear mappings, matrix representation and change of basis (Strang Ch. 7)</td>
</tr>
<tr>
<td></td>
<td>* Determinants and diagonalization of matrices (eigenvalues and eigenvectors) (Strang 6.1, 6.2, 6.5, 6.6)</td>
</tr>
<tr>
<td></td>
<td>* Diagonalization applied to linear differential and difference equations (Strang 6.3)</td>
</tr>
<tr>
<td></td>
<td>* Numerical methods for solving linear systems of equations (Ascher/Greif 5.1, MATLAB Documentation of the MATLAB documentation of the MATLAB functions)</td>
</tr>
<tr>
<td></td>
<td>* Interpolation with polynomials and splines (Ascher/Greif Ch. 10 and 11)</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Knowledge of elementary calculus</td>
</tr>
<tr>
<td>406-0242-AAL</td>
<td>Analysis II</td>
</tr>
<tr>
<td>E- 7 credits</td>
<td>M. Akveld</td>
</tr>
<tr>
<td>Abstract</td>
<td>Mathematical tools of an engineer</td>
</tr>
<tr>
<td>Objective</td>
<td>Mathematics as a tool to solve engineering problems, mathematical formulation of problems in science and engineering. Basic mathematical knowledge of an engineers.</td>
</tr>
<tr>
<td>Content</td>
<td>Multi variable calculus; gradient, directional derivative, chain rule, Taylor expansion, Lagrange multipliers. Multiple integrals: coordinate transformations, path integrals, integrals over surfaces, divergence theorem, applications in physics. Ordinary differential equations.</td>
</tr>
<tr>
<td>Literature</td>
<td>Textbooks in English:</td>
</tr>
<tr>
<td></td>
<td>- J. Stewart: Multivariable Calculus, Thomson Brooks/Cole</td>
</tr>
<tr>
<td></td>
<td>- V. I. Smirnov: A course of higher mathematics. Vol. II. Advanced calculus</td>
</tr>
<tr>
<td></td>
<td>- M. Akveld, R. Sperb, Analysis II, vdf</td>
</tr>
<tr>
<td></td>
<td>- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag</td>
</tr>
<tr>
<td>406-0243-AAL</td>
<td>Analysis I and II</td>
</tr>
<tr>
<td>E- 14 credits</td>
<td>M. Akveld</td>
</tr>
<tr>
<td>Abstract</td>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
</tr>
<tr>
<td>Objective</td>
<td>Mathematics as a tool to solve engineering problems, mathematical formulation of problems in science and engineering. Basic mathematical knowledge of an engineers.</td>
</tr>
<tr>
<td>Content</td>
<td>Multi variable calculus; gradient, directional derivative, chain rule, Taylor expansion, Lagrange multipliers. Multiple integrals: coordinate transformations, path integrals, integrals over surfaces, divergence theorem, applications in physics. Ordinary differential equations.</td>
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<tr>
<td></td>
<td>- M. Akveld, R. Sperb, Analysis II, vdf</td>
</tr>
<tr>
<td></td>
<td>- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag</td>
</tr>
</tbody>
</table>
Abstract

Mathematical tools for the engineer

Objective

Mathematics as a tool to solve engineering problems. Basic mathematical knowledge for engineers.

Mathematical formulation of technical and scientific problems.

Content

Complex numbers. Calculus for functions of one variable with applications. Simple Mathematical models in engineering.


Literature

Textbooks in English:

Textbooks in German:
- M. Akveld, R. Sperb: Analysis I, vdf
- M. Akveld, R. Sperb: Analysis II, vdf
- L. Papula: Mathematik für Ingenieure und Naturwissenschaftler, Vieweg Verlag
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>E-</th>
<th>9R</th>
<th>M. Kalisch</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>E-</td>
<td>4 credits</td>
<td>M. Kalisch</td>
</tr>
</tbody>
</table>

Abstract

Enrolment only for MSc students who need this course as additional admission requirement.

Objective

The objective of this course is to build a solid foundation in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content

From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature

- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under:

  From within the ETH, this book is freely available online under:
  http://www.springerlink.com/content/m17578/
### Lectures and Exercises

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>862-0050-00L</td>
<td>History and Philosophy of Knowledge: Goals, Methods and Work Tech. Only for History and Philosophy of Knowledge MSc.</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>N. El Kassar, M. Hampe, F. Hupfer, A. Mohr, M. Stadler, A. Totzke</td>
</tr>
</tbody>
</table>

**Abstract**

This lecture is important as an Introduction to the Master Programme

The interdisciplinary lecture series are exclusively addressed to the students of the HPK-M.A. programme. They provide an insight into all the disciplines which participate in the M.A. programme and their specific demands, approaches, problems and techniques. Subsequent to the lectures, there will be an opportunity to discuss difficulties and dilemmas within the procedures of thesis-writing. The series should provide and secure a substantial, methodological and formal orientation within the disciplines taught in the M.A.-program.

**Prerequisites / notice**

Dates: Thursday, 10-12

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0125-18L</td>
<td>Self-Ownership - Philosophical and Juridical Perspectives</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>B. Hilmer</td>
</tr>
</tbody>
</table>

**Abstract**

Rights in Objects are founded by an inalienable Self-Ownership. These ideas are central for personal rights. We speak of my body, my genes, my name, my portrait, my ideas or ways of expression.

**Objective**

Participants will make acquaintance with founding texts of the natural rights property concept (John Locke). They will see the connection between inalienable self-ownership, prohibition of slavery, derivative commercial rights and modern personal rights. They will learn about the problems of self-ownership today concerning property in one’s body and intellectual property. Critical alternatives to the property paradigm will be discussed.

Participants will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts and orient themselves in current bioethical, juridical and political discussions.

**Content**

Texts by Locke, Nozick, Christman, Otsuka, Rasmussen, Schneider, Stirmer, Fichte and Forschner. Founding of property right in self-ownership (Locke), revival of this concept in Nozick and his egalitarian critics. Critique of the concept of self-ownership related to property in one’s body. Looking back to the personal self-relatedness that comes up again in Intellectual Property and in modern personal rights.

**Literature**

Text, Seminarplan und Literaturliste in ILIAS Lehrdokumentenablage.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0157-00L</td>
<td>Mind and Brain</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Hagner</td>
</tr>
</tbody>
</table>

**Abstract**

In the last 2500 years, the mind-brain relationship has been articulated in various ways. In these lectures, I will explore the scientific and philosophical aspects of this relationship in the context of relevant cultural, historical and technological processes, with a focus on the modern neurosciences. I will also discuss works of art and literature.

**Objective**

By the end of this lecture, students should be familiar with essential positions in the scientific and philosophical treatment of questions relating the mind to the brain. It should also become clear that some of the most relevant problems in current neurosciences have a long history.

**Content**

According to a myth, the ancient Greek philosopher Democrit dissected animals, because he was in search of the seat of the soul. Current neuroscientists use neuroimaging techniques like functional magnetic-resonance-tomography in order to localize cognitive and emotional qualities in the brain. Between these two dates lies a history of 2500 years, in which the relationship between the mind and the brain has been defined in various ways. Starting with ancient and medieval theories, the lecture will have its focus on modern theories from the nineteenth century onward. I will discuss essential issues in the history of the neurosciences such as localization theories, the neuron doctrine, reflex theory, theories of emotions, neurocybernetics and the importance of visualizing the brain and its parts, but I will also include works of art and literature.

**Literature**

Text, Seminarplan und Literaturliste in ILIAS Lehrdokumentenablage.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0144-15L</td>
<td>The Beginning of Scientific Enquiry - History and Impact of Presocratic Natural Philosophy</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>N. Sieroka</td>
</tr>
</tbody>
</table>

**Abstract**

Several questions and notions introduced by presocratic natural philosophy are still considered important (albeit in historically altered forms, of course). This applies, e.g., to the notion of the infinite, the process character of nature, and atomism. The present lecture discusses both, the origin of these notions and their persistent relevance for later approaches in philosophy.

**Objective**

By the end of the lecture the students are able to describe and classify different approaches and notions in presocratic philosophy. Moreover, they are able to critically compare and evaluate them in relation to later approaches in natural philosophy.

**Content**

Internet aufgaben werden vorausgesetzt.

**Lecture notes**


**Literature**

https://www.tg.ethz.ch/de/programme/
The seminar aims at a clarification of the concept of knowledge, as it is built in our experiential relations to the world. An analysis is needed

The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different

Parasites have a bad reputation. They settle in with other creatures' bodies, they manipulate and deceive them, they live at the expense of

The course provides insight into the complex and intricate history of the parasite and the various definitions of parasitism. In particular, it

What Is Knowledge?

The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different modells of machines will be

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

The course introduces students to what an interdisciplinary approach to literature implies. Students are familiar with the main techniques of

What Is Knowledge?

The course focuses on writers (such as Henry James, Virginia Woolf, Margaret Atwood, Arthur Miller, Charles Dickens, George Eliot and Oscar Wilde) who by approaching the technique of photography i.e. its optical and chemical procedures have discovered novel modes and methods of representation.

Switzerland in the 20th Century: an Economic Social Overview (UZH)

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html


Weitere Informationen unter https://www.tg.ethz.ch/de/programme/

● Objective

Number of participants limited to 80.

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Further information under https://www.tg.ethz.ch/de/programme/

Data: 06.12.2018 13:04

Autumn Semester 2015

Page 671 of 1432
3 credits

J. Ghazoul

Readings in Environmental Thinking

This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, shaping its relevance to society. Above all, the course seeks to give confidence and raise enthusiasm among students to read more widely around the broad subject of environmental sciences and management both during the course and beyond.

Objective

More informations will follow in the lecture.

Prerequisites / notice

Voraussetzungen: Die Bereitschaft, sich auf ein Projekt mit experimentellem Charakter einzulassen. GUTE BEHERRSCHUNG DER DEUTSCHEN SPRACHE.

Die Teilnehmerzahl ist begrenzt. SCHRIFTLICHE ANMELDUNG erforderlich (bis 31. August): uwe.justus.wenzel@nzz.ch

4 credits

851-0129-00L

The Factory of the Origins: Myth and Sciences

In which language has God pronounced «Fiat Lux»? Which discourses have dealt with the origins of religions, nations, languages and «races»? Renan questions if the «destiny» of peoples has ever been driven by racial "instinct". In his Schwarze Hefte (2014-2015), Heidegger speaks about the "metaphysics" of «race». The «origins factory» can be related both to oneself as well as to the others.

Objective

More informations will follow in the lecture.

Prerequisites / notice

Die Teilnehmerzahl ist begrenzt. SCHRIFTLICHE ANMELDUNG erforderlich (bis 31. August): uwe.justus.wenzel@nzz.ch

4 credits

851-0144-01L

Introduction to the Philosophy of Physics

Particularly suitable for students of D-MAVT, D-MATL

This is an introductory course in different areas and positions in the philosophy of physics. It falls into different parts, including one on the concepts of space and time and one on the reality of structures in physics.

Objective

Students should be able to name and critically evaluate different topics and approaches in the philosophy of physics.

Content

The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is not a scientific paper) to identify the key points for discussion.

Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.

These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenting students will summarise the emerging points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes). In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.

The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session. Presentation of the text requires the students to prepare for, by example:

identifying the key points made within the text
identifying issues of particular personal interest and resonance
considering the impact of the text at the time of publication, and its importance now
evaluating the text from the perspective of our current societal and environmental position

Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.

These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenting students will summarise the emerging points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes). In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.

The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session. Presentation of the text requires the students to prepare for, by example:

identifying the key points made within the text
identifying issues of particular personal interest and resonance
considering the impact of the text at the time of publication, and its importance now
evaluating the text from the perspective of our current societal and environmental position

Other students from the course will then have the opportunity to present their own prepared critique of the text (for about 15 minutes) to the rest of the class, with the lecturer facilitating the subsequent class discussion (about 45 minutes) and summarising the emerging points (5 minutes) for the class.

The specific texts selected for discussion will vary, but examples include:

Leopold (1949) A Sand County Almanach
Carson (1962) Silent Spring
Jared Diamond (2005) Collapse

Discussions might also encompass films or other forms of media and communication about nature.
Literature and Technology - Simulations, Prototypes, Machines

This course is aimed at MAPGW students who are particularly interested in theoretical philosophy. The seminar provides an opportunity to discuss and present one's own research. The participants learn to critically evaluate primary texts and improve their skills in presenting and discussing work in progress.

Objective
This course offers students the opportunity to...

Abstract
The course will introduce the concepts of...

Objective
- Students familiarize themselves with...

Content
- Students will be expected to...

851-0300-94L Combinatorics: History of a Method Between Mathematics and Literature

Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

Objective
- Students familiarize themselves with one of the great novels of the 20th century in the context of a diligent reading accompanied by the...

Content
In this seminar, we will study the conflictive relation in more detail. Texts will cover a broad historical spectrum ranging from pre-modern cabinets of wonder to the anti-wonder polemics in the 19th century and the current dispute on Intelligent Design.

Objective
- To get acquainted with different types of infinitness; to study what is intriguing or problematic about the infinite; to inquire whether these different types of infinitness have (important) features in common.

Content
- to critically consider the concepts of science and knowledge
- to understand how advances in technology and science are historically rooted in European imperial expansion and are connected to global social inequalities in the postcolonial world.
- to understand the historical plurality of forms of knowledge in different parts of the world as well as entanglements between different forms of knowledge
- to systematically reconstruct and reproduce complex arguments (reading-competences)
- to understand, compare and analyse differing approaches to the history of science.
- to enable students to form an educated opinion and participate in discussions on the global history of science and knowledge

851-0314-07L The Infinite in Philosophy and in the Exact Sciences: Logic, Mathematics, Physics

Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

Objective
- Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

Content
- Combinatorik, die Verknüpfung von Elementen, tritt als ein Verfahren in unterschiedlichen Disziplinen und Bereichen des Wissens auf: in der Mathematik, wo man sie zuerst vermutet, ermöglicht sie die Berechnung von Anzahlen und Wahrscheinlichkeiten. Zugleich spielt die Kombinatorik auch eine grosse Rolle in der Philosophie (als ein Verfahren zur Erzeugung eines enzyklopädischen Wissens), in der Mystik (zur Erlangung ekstatischer Erfahrung) und in der Literatur (als ein experimentelles Schreibverfahren). In dem Seminar werden die...

Objective
- To understand, compare and analyse differing approaches to the history of science.

Content
- to systematically reconstruct and reproduce complex arguments (reading-competences)
- to understand, compare and analyse differing approaches to the history of science.
- to enable students to form an educated opinion and participate in discussions on the global history of science and knowledge

851-0306-05L History and Philosophy of Pharmacy

Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

Objective
- Particularly suitable for students of D-CHAB.

Content
- "Materialmoränen": Thomas Mann’s Zauberberg from the Point of View of the History of Knowledge

Objective
- Students familiarize themselves with one of the great novels of the 20th century in the context of a diligent reading accompanied by the...

Content
- on the basis of the primary text, the seminar establishes several perspectives grounded in cultural history, the history of knowledge and ideas, economic and social history and the history of medicine.

Objective
- Particularly suitable for students of D-MATH, D-MATL

Content
- Combinatorics in literature and literary theory

Objective
- to critically consider the concepts of science and knowledge
- to understand how advances in technology and science are historically rooted in European imperial expansion and are connected to global social inequalities in the postcolonial world.
- to understand the historical plurality of forms of knowledge in different parts of the world as well as entanglements between different forms of knowledge
- to systematically reconstruct and reproduce complex arguments (reading-competences)
- to understand, compare and analyse differing approaches to the history of science.
- to enable students to form an educated opinion and participate in discussions on the global history of science and knowledge

Objective
- Particularly suitable for students of D-MATH, D-MATL

Content
- Combinatorics in philosophy and the natural sciences

Objective
- Particularly suitable for students of D-MATH, D-MATL

Content
- Combinatorics in theology, mysticism and occultism

Objective
- Particularly suitable for students of D-MAVT, D-MATL

Content
- Combinatorics in literature and literary theory

Objective
- Particularly suitable for students of D-MATH, D-MATL

Content
- Combinatorics in philosophy and the natural sciences

Objective
- Particularly suitable for students of D-MATH, D-MATL

Content
- Combinatorics in theology, mysticism and occultism

Objective
- Particularly suitable for students of D-MATH, D-MATL

Content
- Combinatorics in literature and literary theory

Objective
- Particularly suitable for students of D-MATH, D-MATL

Content
- Combinatorics in philosophy and the natural sciences

Objective
- Particularly suitable for students of D-MATH, D-MATL

Content
- Combinatorics in theology, mysticism and occultism

Objective
- Particularly suitable for students of D-MATH, D-MATL

Content
- Combinatorics in literature and literary theory
The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It focuses on the correlation of the contemporary scientific and technological developments and the conceptions of a 'New Man'. The discussions cover psychotechnical and cognitive designs of scientific and technological minds and ways of human living and perception. In the seminar, we will examine the utopian visions of life in the avantgarde movements. Touching upon the fields of the life sciences, economics, management, progressive education, architecture, and art we will reflect the diverse relations between science, technology, and human living.

1. Analysis and discussion of different interpretations of the virtue "wisdom".

Wisdom is widely - maybe even universally, at all times and everywhere - regarded as one of the highest virtues. But what constitutes wisdom? And is wisdom compatible with uncertainty? Does a wise person have to be certain or can she be uncertain? These and related questions will be discussed in the seminar to gain an understanding of what wisdom, certainty and uncertainty are.


Wisdom is widely - maybe even universally, at all times and everywhere - regarded as one of the highest virtues. But what constitutes wisdom? And is wisdom compatible with uncertainty? Does a wise person have to be certain or can she be uncertain? These and related questions will be discussed in the seminar to gain an understanding of what wisdom, certainty and uncertainty are.

3. Discussion of the questions what constitutes wisdom today and whether wisdom is a goal of the good life.

4. Examination of the relevance of wisdom in practical and theoretical contexts.

The seminar is fully booked!
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>851-0125-52L</td>
<td>Central Questions in Bioethics</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>L. Wingert</td>
</tr>
<tr>
<td>851-0148-02L</td>
<td>Manifolds and Individuation in Mathematics</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>T. Böhm</td>
</tr>
<tr>
<td>851-0300-97L</td>
<td>Return of Religions, 'Religious turn', Postsecularity: On the Contemporary Prominence of Religions</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>D. Weidner</td>
</tr>
</tbody>
</table>

**Objective**

- **Central Questions in Bioethics**
  - Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like "Protect the dignity of the living being!", or "Respect a person's self-determination"? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account.
  - Es sollen normative Prinzipien identifiziert werden, die oft faktisch bioethischen Entscheidungen zu Grunde liegen. Und es sollen überzeugende Prinzipien ermittelt werden.
  - Zugleich sollen die Teilnehmer Kenntnisse erwerben über die Entwicklungen in zeitgenössischen Gesellschaften westlichen Typs (mit individuellen Grundrechten, kapitalistischer Marktwirtschaft und systematische wissenschaftlicher Forschung), die mit der Dynamik von Biotechniken zusammehängen.

- **A Historical Epistemology of Exhibitions**
  - The seminar provides an introduction to exhibitions as epistemic practices. By means of various research approaches and examples from historical and current exhibitions we will discuss how knowledge is created by temporary spatial constellations of exhibited objects and the ways exhibitions act as laboratories of ideas.
  - The seminar aims at getting to know the theoretical and practical conditions of exhibitions as temporary forms of knowledge. We will develop criteria to explore the various aspects and processes related to exhibitions, including: installations of exhibits, display cases, transporting devices, exhibition catalogues, exhibition architecture, visitor guidance, spatial arrangements of objects etc.
  - Using selected historical and current examples, we will discuss different formats of exhibitions that range from trade fair booths to laboratory exhibitions, exhibitions in art museums as well as in science and natural museums. Being a specific humanistic way of creating knowledge experimentally we will pay particular attention to exhibitions that deal with topics at the intersection of the sciences and the humanities, thus acting as agents in the debate on the Two Cultures.

**Literature**

- 1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.

- Svetlana Alpers: The Museum as a Way of Seeing, in: Ivan Karp, Steven D. Levine (Hg.): Exhibiting Cultures. The Poetics and Politics of
- Manifolds and Individuation in Mathematics and
- Sharing. The History of an Attractive Technology
- HEST, D-MAVT, D-MATL


**Data:** 06.12.2018 13:04

**Autumn Semester 2015**
Term Paper History of Technology (HS 2015)

Objective
The students get familiar with different theories of religion and of the relation of religion and modernity in particular. They discuss the conceptual and epistemological implications of these theories and understand the problems of determining religion, especially under modern conditions. They reflect on the differences and even conflicts between different approaches and face their respective ideas about modernity. The course thus also aims to deepen the self-understanding of our modern standpoint in relation both to one's own religious identity and history and to the religion of "Others".

Abstract
The difference between the natural sciences and the humanities is often characterized in terms of their relation to history: here rigorous method & transhistorical laws, there historically conditioned, and hence relative, understanding. But the discrepancy between transhistorical immanence and historical constitution figures also within both disciplines. We will discuss precisely this discrepancy.

Objective
- reflect on the ideal of scientific rigor, as well as the historical constitution of all knowledge;
- question the paradigm of historicity with regard to both the natural sciences and the humanities;
- critical reading of theoretical and literary texts that deal with the tension between scientificity and historicity.

Content

Literature

Semester Report

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>862-0006-00L</td>
<td>Semester Report</td>
<td>O</td>
<td>3</td>
<td>3A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
The report is a critical selfassessment of the students development during the last semester.

Objective
The report should lead to the competence to judge the relation between curricula design and fostered or prevented learning processes.

Term Paper History of Technology (HS 2015)

Abstract
Term paper that allows students to explore a topic of their choice in greater depth, applying the fundamental knowledge they have acquired so far.

Objective
Term paper that allows students to explore a topic of their choice in greater depth, applying the fundamental knowledge they have acquired so far.

Term Paper in Science of Knowledge (HS 2015)

Abstract
Term paper that allows students to explore a topic of their choice in greater depth, applying the fundamental knowledge they have acquired so far.

Objective
Term paper that allows students to explore a topic of their choice in greater depth, applying the fundamental knowledge they have acquired so far.

Term Paper in Theoretical Philosophy (HS 2015)

Abstract
This paper is based on the active participation in the actual seminar. It concentrates on one aspect of the seminar's general topic in the history of technology and must develop a sound approach to a well-defined corpus of historic sources.

Objective
Developing a case-specific approach, coping with relevant literature and an enhancing one's competence in the critical evaluation of historic sources are the learning targets of this course.

Term Paper in Practical Philosophy (HS 2015)

Abstract
This paper is based on the active participation in the actual seminar. It concentrates on one aspect of the seminar's general topic in the history of technology and must develop a sound approach to a well-defined corpus of historic sources.

Objective
Developing a case-specific approach, coping with relevant literature and an enhancing one's competence in the critical evaluation of historic sources are the learning targets of this course.

Term Paper in Literature and Culture (HS 2015)

Abstract
This paper is based on the active participation in the actual seminar. It concentrates on one aspect of the seminar's general topic in the history of technology and must develop a sound approach to a well-defined corpus of historic sources.

Objective
Developing a case-specific approach, coping with relevant literature and an enhancing one's competence in the critical evaluation of historic sources are the learning targets of this course.

Term Paper History of the Modern World (HS 2015)

Abstract
This paper is based on the active participation in the actual seminar. It concentrates on one aspect of the seminar's general topic in the history of technology and must develop a sound approach to a well-defined corpus of historic sources.

Objective
Developing a case-specific approach, coping with relevant literature and an enhancing one's competence in the critical evaluation of historic sources are the learning targets of this course.

Major Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>862-0013-13L</td>
<td>Term Paper History of the Modern World (HS 2015)</td>
<td>W</td>
<td>5</td>
<td>1A</td>
<td>Lecturers</td>
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</tbody>
</table>

Abstract
This paper is based on the active participation in the actual seminar. It concentrates on one aspect of the seminar's general topic in the history of technology and must develop a sound approach to a well-defined corpus of historic sources.

Objective
Developing a case-specific approach, coping with relevant literature and an enhancing one's competence in the critical evaluation of historic sources are the learning targets of this course.

In each subject of the master reading lists are handed out. The books on these lists are the subject of the tutorials one has to attend with the teachers.

In the seminars topics from the introductory courses are taught in more detail. Topics for essays are to be arranged with the teachers of the courses.

### Seminars

#### In the seminars topics from the introductory courses are taught in more detail. Topics for essays are to be arranged with the teachers of the courses.

#### Number Title Type ECTS Hours Lecturers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>862-0027-00L</td>
<td>Essay on Readings in Practical Philosophy (HS)</td>
<td>W</td>
<td>8</td>
<td>17A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>This essay is the outcome of an individual teaching and learning process during several terms and draws upon representative books and articles in history of technology. It has to consider the state of the art in the field.</td>
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<tr>
<td>Objective</td>
<td>Writing this essays intends to become acquainted with methods, tools and concepts relevant for the students master thesis.</td>
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<td></td>
</tr>
<tr>
<td>862-0029-00L</td>
<td>Essay on Readings in Literature and Culture (HS)</td>
<td>W</td>
<td>8</td>
<td>17A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>This essay is the outcome of an individual teaching and learning process during several terms and draws upon representative books and articles in history of technology. It has to consider the state of the art in the field.</td>
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<td>862-0031-00L</td>
<td>Essay on Readings in History of the Modern World (HS)</td>
<td>W</td>
<td>8</td>
<td>17A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>This essay is the outcome of an individual teaching and learning process during several terms and draws upon representative books and articles in history of technology. It has to consider the state of the art in the field.</td>
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</tbody>
</table>

#### Research Colloquium

```text
```
Ideas and arguments dealing with systematic problems especially in epistemology, ethics, political philosophy, and the philosophy of mind.

The colloquium addresses advanced and graduate students. First, it offers participants the opportunity to present their own research.

Ph.D. students and members of staff report on their research.

Ph.D. students, post docs, members of staff, and senior colleagues from other philosophy departments will report on their work in progress.

H. Fischer-Tiné

ECTS: 2 credits

Hours: 64D

This colloquium is devoted to the introduction into the theory and practice of scientific work. The schedule can be found on the institute's website - http://www.wiss.ethz.ch/en/teaching/

This colloquium is designed for advanced and graduate students.

Colloquium for master and doctoral students preparing a thesis in the history of technology.

Colloquium for Master and Ph.D. Students

Goals: to identify, discuss, and resolve methodological problems that emerge while elaborating a master or doctoral thesis.

Participants will acquire an systematic overview of different definitions of and approaches to Global History.

What distinguishes Global History - conceptually and empirically - from other modes of historical inquiry? This research colloquium will focus on present developments, debates and perspectives in the field of history of knowledge. On the second and fourth date there will be public events in the Cabaret Voltaire. Check the program on www.zgw.ethz.ch

Furthermore, promising new philosophical articles and parts of new philosophical books will be studied.

Doctoral students will have the opportunity to improve their presentation skills and obtain an important chance to receive feedback both from peers and more advanced scholars.

This colloquium is highly recommended for first and second semester MAGPW students.

This colloquium is designed for advanced and graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic complex issues.

The colloquium addresses advanced and graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic complex issues.

Goals: to identify, discuss, and resolve methodological problems that emerge while elaborating a master or doctoral thesis.

Beginn 2. Semesterwoche, 22.9.2015 (alle 14 Tage). Anmeldung bei Gisela Hürlimann (gisela.huerlimann@history.gess.ethz.ch), Siehe www.tg.ethz.ch

This colloquium provides a collegial and non-competitive forum for young researchers to discuss these questions. We shall examine programmatic texts on Global History and connect them to source materials from our own research projects.

Participants will acquire an systematic overview of different definitions of and approaches to Global History.

They will be able to position their own approach within the field of Global History and gain a clearer understanding on how to examine their source materials.

Ph.D. students, post docs, members of staff, and senior colleagues from other philosophy departments will report on their work in progress. Furthermore, promising new philosophical articles and parts of new philosophical books will be studied.

Ideas and arguments dealing with systematic problems especially in epistemology, ethics, political philosophy, and the philosophy of mind will be scrutinized and elaborated.

Master Thesis

The work on the master-thesis is supervised by one of the teachers that are allowed to offer tutorials for it, named in the Leitfaden.

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The work on the master-thesis is supervised by one of the teachers that are allowed to offer tutorials for it, named in the Leitfaden.

Number
Title
Type
ECTS
Hours
Lecturers

862-0500-00L
Master's Thesis
O
30 credits
64D
Supervisors

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 678 of 1432
all credits have been acquired in the categories basic courses and major courses and at least 6 credits have been acquired in the category research colloquium

Abstract
The Master's thesis gives a thorough historical, philological or philosophical analysis of a topic related to the experimental or formal sciences or to technology. It incorporates the relevant research literature on this topic as well as first attempts at original research.

Objective
The master thesis gives a thorough historical, philological or philosophical analysis of a topic related to the experimental or formal sciences or to technology. It incorporates the relevant research literature on this topic as well as first attempts at original research.

### History and Philosophy of Knowledge Master - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

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<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The text-book “Biology” (Campbell, Reece) (10th edition) is the basis of the course.

Mathematics I

Mathematics I/II is an introduction to one- and multidimensional calculus.

The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

- W. Uhlig
- A. Caspar

The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.

Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci. & Tech.)

Fundamentals of Organic Chemistry; molecular structure. Bonding and functional groups; nomenclature; resonance and aromaticity; stereochemistry; conformation; bond strength; organic acids and bases; basic reaction thermodynamics and kinetics; reactive intermediates: carbanions, carbenium ions and radicals.

Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Understanding the relationship between structure and reactivity.


Printed lecture notes are available. Exercises, answer keys and other handouts can be downloaded from the Moodle course "Organic Chemistry I" of the current semester (https://moodle-app2.let.ethz.ch).

The course consists of plenary lectures (2 h per week) and problem-solving lessons (2 h per week, groups of ca. 25 people). In addition, online exercises are available in the e-learning environment Moodle (Course OC I).

Content

## Eindimensionale diskrete Entwicklungen ##
- linear, exponentiell, begrenzt, logistisch
- Fixpunkte, diskrete Veränderungsrate
- Folgen und Grenzwerte

## Funktionen in einer Variablen ##
- Reproduktion, Fixpunkte,
- Periodizität,
- Stetigkeit

## Differentialrechnung (I) ##
- Veränderungsrate/-geschwindigkeit
- Differentialquotient und Ableitungsfunktion
- Anwendungen der Ableitungsfunktion

## Integralrechnung (I) ##
- Stammfunktion
- Integrationstechniken

## Gewöhnliche Differentialgleichungen (I) ##
- Qualitative Beschreibung an Beispielen:
  - Beschränkt, Logistisch, Gompertz
  - Stationäre Lösungen
  - Lineare DGL 1. Ordnung
  - Trennung der Variablen

## Funktionen in einer Variablen ##
- Reproduktion, Fixpunkte,
- Periodizität,
- Stetigkeit

## Differentialrechnung (I) ##
- Veränderungsrate/-geschwindigkeit
- Differentialquotient und Ableitungsfunktion
- Anwendungen der Ableitungsfunktion

## Integralrechnung (I) ##
- Stammfunktion
- Integrationstechniken

## Gewöhnliche Differentialgleichungen (I) ##
- Qualitative Beschreibung an Beispielen:
  - Beschränkt, Logistisch, Gompertz
  - Stationäre Lösungen
  - Lineare DGL 1. Ordnung
  - Trennung der Variablen

Lecture notes

In Ergänzung zu den Vorlesungskapiteln der Lehrveranstaltungen fassen wir wichtige Sachverhalte, Formeln und weitere Ausführungen jeweils in einem Vademecum zusammen. Die pdfs finden Sie unter Lernmaterial > Dokumente.

Dabei gilt:

* Die Skripte ersetzen nicht die Vorlesung und/oder die Übungen!
* Ohne den Besuch der Lehrveranstaltungen verlieren die Ausführungen ihren Mehrwert.
* Details entwickeln wir in den Vorlesungen und den Übungen, um die hier bestehenden Lücken zu schliessen.
* Prüfungsrelevant ist, was wir in der Vorlesung und in den Übungen behandeln.

Literature

**Th. Wihler**
Mathematik für Naturwissenschaften, 2 Bände:
Einführung in die Analysis, Einführung in die Lineare Algebra;
Haupt-Verlag Bern, UTB.

**H. H. Storrer**
Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser.
Via ETHZ-Bibliothek:
http://link.springer.com/book/10.1007/978-3-0348-8598-0/page/1

**Ch. Blatter**
Lineare Algebra; VDF
auch als [pdf](http://www.math.ethz.ch/~blatter/dlp.html)

Prerequisites /

## Übungen und Prüfungen ##

+ Die Übungsaufgaben (inkl. Multiple-Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung.
+ Es wird erwartet, dass Sie mindestens 75 % der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.
+ Der Prüfungsstoff ist eine Auswahl von Themen aus Vorlesung und Übungen. Für eine erfolgreiche Prüfung ist die konzentrierte Bearbeitung der Aufgaben unerlässlich.

## Einschreibung in die Übungen ##

Die Einschreibung in die Übungsgruppen erfolgt online.
Alle unter http://www.mystudies.ethz.ch/ für die Vorlesung Eingeschriebenen erhalten rechtzeitig per Email einen personalisierten Link zur Einschreibung.
Behalten Sie diesen Link.

## Zugang Übungsserien ##

Erfolgt auch online.
Alle unter http://www.mystudies.ethz.ch/ für die Vorlesung Eingeschriebenen erhalten rechtzeitig per Email einen 2. personalisierten Link.
Behalten Sie auch diesen Link.

252-0852-00L Foundations of Computer Science O 4 credits 2V+2U

J. Hromkovic, H.J. Böckenhauer,
M. Dahinden, L. E. Fässler,
D. Komm

Abstract

Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.
The students learn to
- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science, process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

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

376-0003-00L Introduction to Health Sciences and Technology I  1 credit  O  4V+2U  R. Müller

Abstract
Overview on various aspects of health and disease (health models, classification of diseases, prevention and rehabilitation, therapy, epidemiology); introduction to technical aspects (measurement technique, etc.); fundamentals of scientific working (ethics, literature search, study design, data collection, data analysis and data presentation).

Objective
Students should know the terms, models and classification systems used in health and disease; in addition, they should understand the methods of scientific working.

Content
- Health: biomedical model and classification of diseases, salutogenesis and ICF, prevention and rehabilitation, therapy, epidemiology.
- Technology: measurement technology, automatic control engineering.
- Science: ethics, literature search, study design, tests, data analysis, data presentation.

First Year Laboratory Courses

Number  Title  Type  ECTS  Hours  Lecturers
376-0003-00L  Demonstration Week Health Sciences and Technology  O  4 credits  2V+2U  R. Müller, W. Langhans, S. Lorenzetti, R. Riener, M. Ristow, M. E. Schwab, N. Wenderoth, further lecturers

Abstract
Delivery of practical insight into research methods relevant to the field by means of demonstrations and small projects in the areas of Human Movement Science, Health Technologies, Molecular Health Sciences, and Neurosciences.

Objective
Students can experience research methods that may arise in the field of Health Sciences and Technology.

Content
- Human Movement Science: movement analysis, biomechanical measurement techniques
- Health Technologies: prostheses
- Molecular Health Sciences: metabolism, behaviour
- Neurosciences: neurological measurement techniques, neurorehabilitation
- Clinical Research

Second Year Compulsary Subjects

Examination Blocks

Block 1

Number  Title  Type  ECTS  Hours  Lecturers
551-0103-00L  Fundamentals of Biology II: Cell Biology  O  5 credits  5V  E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner

Abstract
The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Objective
The goal of this course is to provide students with a wide general understanding cell biology. This material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Lecture notes
The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

Literature

Prerequisites / notice
Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

376-0002-00L Product Design in Medical Engineering  O  4 credits  2V+2U  S. J. Ferguson

Abstract
This course will provide insight into various aspects of medical device design such as patient needs assessment, product specification, research and technical design, validation, regulatory affairs and clinical evaluation.

Objective
The goal of this lecture series is to enable the students to (i) identify the principal functional requirements for a medical device, (ii) to understand the mechanical properties of natural tissues and synthetic biomaterials, (iii) to apply this information and a basic knowledge of mechanics in the calculation of implant performance, (iv) to develop a plan for the pre-clinical evaluation and regulation of a new device.
Content

1. Introduction to Medical Technology
2. Design Process
3. Mechanics
4. Mechanics of Materials
5. Tissue Mechanics
6. Prostheses: Biomechanics and Design
7. Prostheses: Biomaterials, Surfaces and Wear
8. Allografts: Heart Valves
9. Preclinical Evaluation
10. Regulatory Affairs (MepV, FDA, CE)
11. Intellectual Property
12. Group Work and Presentation

Lecture notes
https://moodle-app2.let.ethz.ch/course/view.php?id=180

Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0293-00L</td>
<td>Mathematics III</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>E. W. Farkas</td>
</tr>
<tr>
<td>Abstract</td>
<td>Vertiefung der mehrdimensionalen Analysis mit Schwerpunkt in der Anwendung der partiellen Differentialgleichungen, Vertiefung der Linearen Algebra und Einführung in die Systemanalyse.</td>
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<tr>
<td>Objective</td>
<td>Vertiefung und Ausbau des Stoffes Mathematik I/II für die Anwendung in der Systemanalyse.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites/notice</td>
<td>Vorlesungen Mathematik I/II</td>
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Examination Block 3

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0151-00L</td>
<td>Anatomy I and Physiology I</td>
<td>O</td>
<td>6</td>
<td>4V</td>
<td>M. Ristow, M. Flück, L. Slomianka, C. Spengler, N. Wenderoth, D. P. Wolfer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, the neuro-muscular system, the cardiovascular system and the respiratory system.</td>
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<tr>
<td>Objective</td>
<td>Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.</td>
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<tr>
<td>Content</td>
<td>Short overview of human anatomy, physiology and general pathology.</td>
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<tr>
<td>Prerequisites/notice</td>
<td>Voraussetzungen: 1. Jahr, naturwissenschaftlicher Teil</td>
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<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0043-00L</td>
<td>Physics I</td>
<td>O</td>
<td>4</td>
<td>3V+1U</td>
<td>M. R. Meyer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.</td>
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<tr>
<td>Objective</td>
<td>The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.</td>
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</tbody>
</table>
Advanced Anatomy and Physiology I (fall term):

- The aim of this course is to understand molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to
- The mechanisms of disease development will be studied. Main topics will be: Genetic regulation of disease development with a focus on

Exercise Physiology

- Advanced Anatomy and Physiology I (fall term):
  - Closer look to the nervous system,
  - Advanced Anatomy and Physiology II (spring term):
    - Introduction to Molecular Biology; Closer look to muscles, cardiovascular system, and respiratory system as well as immunology.

Movement- and sports biomechanics deals with the attributes of the human body and their link to mechanics. The course includes topics such as functional anatomy, biomechanics of daily activities (gait, running, etc.) and looks at movement in sport from a mechanical point of view. Furthermore, simple reflections on the loading analysis of joints in various situations are discussed. Additionally, questions covering the statics and dynamics of rigid bodies, and inverse dynamics, relevant clinical biomechanics are investigated.

Online material is provided during the course.

Introduction to biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering.

Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.
376-1714-00L Biocompatible Materials W 4 credits 3G K. Maniura, J. Möller, M. Zenobi-Wong

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts can be accessed online.

Literature
(available online via ETH library)

227-0385-10L Biomedical Imaging W 6 credits 5G S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin

Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

Focus Courses: Neurosciences

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>376-1305-00L</td>
<td>Development of the Nervous System</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>E. Stoeckli, further lecturers</td>
</tr>
</tbody>
</table>

Abstract
The course covers the development of the nervous system (NS) with focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

Objective
The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.

Content
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Lecture notes
Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/ and BC044

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice
Auxiliary tools:
None. Bring something to write and your student ID

| 376-1305-01L | Structure, Plasticity and Repair of the Nervous System | W    | 3    | 2V    | M. E. Schwab, L. Filli, K. A. Martin, further lecturers |

Abstract
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual

Main topics of the course include:
- Introduction to mathematical signal processing and system theory.

Objective
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Literature

Prerequisites / notice
Three tests are offered for practicing the course material. Participation is voluntary.

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<tr>
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</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
</tbody>
</table>

Abstract
Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.

Objective
Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.

Content
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation.

Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

Lecture notes
Script as well as additional material in the form of hand-outs will be distributed.

Literature
Lecture notes and references therein.

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<tr>
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<tbody>
<tr>
<td>151-0575-01L</td>
<td>Signals and Systems</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>R. D'Andrea</td>
</tr>
</tbody>
</table>

Abstract
Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.

Objective
Master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercises.

Content

Lecture notes
Lecture notes available on course website.

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
</tbody>
</table>

Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Lecture notes
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites / notice
The lecture will be taught in English.

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>151-0917-00L</td>
<td>Mass Transfer</td>
<td>W</td>
<td>4</td>
<td>2V+2U</td>
<td>R. Büchel, S. E. Pratsinis</td>
</tr>
</tbody>
</table>

Abstract
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Objective
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Literature

Prerequisites / notice
The lecture will be taught in English.

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>227-0045-00L</td>
<td>Signals and Systems I</td>
<td>W</td>
<td>4</td>
<td>2V+2U</td>
<td>H. Bölcskei</td>
</tr>
</tbody>
</table>

Abstract

Objective
Introduction to mathematical signal processing and system theory.

Content

Lecture notes
Lecture notes, problem set with solutions.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>327-0103-00L</td>
<td>Introduction to Materials Science</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>L. Heyderman, M. Niederberger, P. Uggowitzer</td>
</tr>
</tbody>
</table>

Abstract
Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.

Objective
Basic concepts in materials science.
Contents:
Atomic structure
Atomic bonds
Crystalline structure, perfection - imperfection
Diffusion
Mechanical and thermal properties
Phase diagrams
Kinetics
Structural materials
Electric, magnetic and optical properties of materials
Materials selection criteria

Literature
James F. Shackelford
Introduction to Materials Science for Engineers

376-0130-00L Laboratory Course in Exercise Physiology  ■  W  3 credits  4P  C. Spengler, B. Wilms
Number of participants limited to 36.

Abstract
Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

Objective
Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today’s Sports Medicine.

Content
Labaratory course:
Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

Literature
Tutorial on Laboratory Experiments in Exercise Physiology
(Founder: Exercise Physiology Lab)

Literature
Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg
Kenney/Wilmore/Costill: Physiology of Sport and Exercise, Human Kinetics

Prerequisites / notice
Prerequisite:
Anatomy and physiology classes and lab course in physiology successfully completed (BWS students please contact C. M. Spengler)

Desirable:
Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)

376-1033-00L History of Sports  W  2 credits  2V  M. Gisler

Abstract
Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Objective
Understanding for the development and adaptation of sports from the ancient world to present times.

Content

Literature
Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Literature

376-1107-00L Sport Pedagogy  W  2 credits  2V  D. Seiler Hubler

Abstract
Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

Objective
To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Content
Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik
- Bedeutung des Sports im Kindes- und Jugendalter
- Leistungssport im Kindes- und Jugendalter
- Pädagogische Perspektiven des Sportunterrichts in der Schule
- Ein zeitgemäßer Schulsport
- Bewegungskulturelle Bildung; Bewegungserziehung, Spielerziehung

Literature
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

376-1111-00L Health and Posture I  W  2 credits  2G
Number of participants limited to 30.

Abstract
Analysis of posture: Development of the functionally correct posture
Perception, measurement
Observation of body sections: statics, norm, constitution

Objective
Analysis of posture: Development of the functionally correct posture
Perception, measurement
Observation of body sections: statics, norm, constitution
Content - Perception of the own posture - Analysis of the own posture - Status of the posture standing - Own training program - Neutral liability on the - Back injuries - healthy back 

Tension / Stability 
- Tone regulation 
- sensomotor activity (treats the capacity to feel the own movements, transfer from theory into practice of programming and modifying neuromotoric movements) 
- Torso stability 1, 2 

Relaxation: 
Work-life - Balance Mental training 
Ideas for relaxation (also for kids) Stress regulation 
Massage (introduction in Massage technics)

376-1117-00L Sport Psychology W 2 credits 2V H. Gubelmann

Abstract This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

Objective Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

Content Main Topics 
- Introduction to sport psychology 
- Cognitions in sports: mental rehearsal and mental training 
- Emotions and stress 
- Motivation: goal-setting in sports 
- Career and career transition in elite sport 
- Coach-Athlete-Interaction 
- Psychological aspects of sport-injury rehabilitation 
- Group dynamics in sport 

Lecture notes Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.


376-1127-00L Sociology of Sport W 2 credits 2V M. Lamprecht

Abstract These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

Objective The lectures set out to: 
- present the different dimensions, functions and interrelationships of present-day sport 
- provide an introduction to the central theories and models of (sport) sociology 
- show how far sport reflects society and how it changes and becomes more differentiated in the process 
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

Content Sport and social change: developments and trends 
The economy and the media: dependencies, consequences, scandals 
Social inequalities and distinctions: gender differences and group behavior 
Conflicts and politics: sports organizations, doping, violence 

Lecture notes Selected materials for the lecture are available under www.LSSFB.ch --> Lehre

Literature 

A detailed program with additional references will be delivered at the beginning of the lecture.

376-1155-00L The Musculoskeletal System and Work W 3 credits 2V T. Läubli

Abstract Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

Objective Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal system during work. Prevention and rehabilitation of work related musculoskeletal disease will be discussed with the help of a bio-psycho-social model. Furthermore, evidence based methods for a healthy work design will be presented.

Content Insights of human movement sciences concerning wear, overstraining and regeneration of the musculoskeletal system form an important basis for an ergonomic work design. The following topics will be covered: Muscle fatigue in an 8-hours-day, mouse appliance, back pain, insertion tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, and measurement methods.

Lecture notes Skript und Folien auf NETZ als PDF-Datei zur Verfügung


376-1581-00L Cancer: Fundamentals, Origin and Therapy W 2 credits 2G H. Nägeli


Interactions between chemicals and DNA. Test systems to recognize mutagenic chemicals. Conventional and new therapeutic strategies.

Objective Students are able to describe selected chemicals, biological and molecular processes that occur in cells spontaneously or after physical or chemical exposure and resulting in a tumor. They are able to list important cancer-inducing agents and explain the respective mechanism of action. They have knowledge of significant risk factors for cancer diseases. They are confronted with the basics of toxicology and they can explain the principle of the most common therapeutic strategies.

The lecture deals with problems of tumor epidemiology (causes, mortality, incidence). Cancer is delineated as a multi-step process. Classes of chemical compounds that induce cancer are discussed as well as the reactive metabolites that may be built from. Phenomenons like angiogenesis and metastasis are presented as well as the mechanisms that protect the genome from mutagenic damage. The reason for genetic predisposition to cancer will be discussed as well as cancer relevant aspects of cell cycle regulation. Further subjects address old and new strategies of cancer treatment. Personalised cancer treatment.

The lecture requires an active participation of the students. All students will participate in individual or group work focussing on specific subject of the lecture. Students will have ample time for preparation during lecture time.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Basics of Exercise Therapy</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>K. Marschall</th>
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</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Basics of Exercise Therapy:</td>
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<tr>
<td></td>
<td>A: diagnostic, anamnesis, diagnostic of movement and funktion, assessments in exercise therapy, diagnostic of experience and behavior in relation to movement</td>
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<tr>
<td></td>
<td>B: biological-medical basics biomechanic (joints), pathophysiologische Basics (internal, orthopedic and psychological deseases.)</td>
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<td></td>
<td>C: didactic knowledge, Reha-didactic</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students learn the assessments to plan an exercise-therapy-treatment.</td>
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<tr>
<td></td>
<td>They are able to use them. They're able to integrate biological and medical basics.</td>
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<tr>
<td></td>
<td>They are able to prepare a therapy-session</td>
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<tr>
<td><strong>Content</strong></td>
<td>Grundlagen der Diagnostik, Anamnese, Bewegungsdiagnostik, Funktionsdiagnostik</td>
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<tr>
<td></td>
<td>Sport- und Bewegungstherapeutische Testverfahren</td>
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<tr>
<td></td>
<td>Motorische Basisdiagnostik</td>
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<tr>
<td></td>
<td>Diagnostik bewegungsbezogenen Erlebens und Verhaltens</td>
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</tr>
<tr>
<td></td>
<td>Biologisch-medizinische Grundlagen</td>
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<tr>
<td></td>
<td>Biomechanik (v.a. Gelenke), Pathophysiologische Grundlagen, Modelle der Methodik und Didaktik, Lektionsplanung</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>the lecture &quot;Introduction in Exercise Therapie&quot; ist prerequisite</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>90% of the lections students must be present.</td>
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</tbody>
</table>
The members are able to transform the knowledge from the previous courses in practical situations of Sports and Exercise Therapy. They learn basic aspects to design therapy lessons.

Prerequisite: "Introduction of Exercise Therapy” passed. The courses "Introduction in Sports and Exercise Therapy" and "Practical Basics in Sports and Exercise Therapy" has been completed successfully.

Impart knowledge of practical basics of Sports and Exercise Therapy

Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

General literature:

G.A. Zäch, H. G. Koch
Paraplegie - ganzheitliche Rehabilitation
Karger-Verlag, 2006
ISBN 3-8055-7980-2

V. Goosey-Tolfrey
Wheelchair sport: A complete guide for athletes, coaches and teachers
Human Kinetics, 2010

Y.C. Vanlandewijck, W.R. Thompson
The Paralympic Athlete
Wiley-Blackwell, 2011
ISBN 978-1-4443-3404-3

Liz Broad
Sports Nutrition for Paralympic Athletes
CRC Press 2014

Voraussetzung: Vorlesung Anatomie/Physiologie besucht!

Mainly based on recent original literature, a detailed list will be distributed during the first lecture

Physical Chemistry I (for Biology and Pharmacy)

The lectures give an overview of selected drugs and the molecular mechanisms underlying their therapeutic effects in disease. The historical and modern-day methods by which these drugs were discovered and developed are described. Structure-function relationships and the biological rules underlying ligand-target interactions will be discussed and illustrated with examples.

Basic understanding of therapeutic agents with respect to molecular, pharmacological and pharmaceutical properties.

Will be provided in parts before each individual lecture.

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 690 of 1432
## Literature


## Prerequisites / notice

### 535-0421-00L

**Galenic Pharmacy I**

W 2 credits 2G  

**Abstract**

Principles and technologies for the manufacturing of dosage forms and drug delivery systems. Knowledge of pharm. excipients, materials, containers, liquid and semi-solid dosage forms, their production, function, quality and application. Comprehension of molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dosage forms.

**Objective**

Knowledge of the most important pharmaceutical excipients, materials, containers, liquid and semi-solid dosage forms, of their production, function, quality, stability and application. Comprehension of the molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in disperse dosage forms.

**Content**

Introduction and overview of important fundamentals, principles and technologies for the development and manufacturing of dosage forms and drug delivery systems. Overview of the most important pharmaceutical excipients and polymers, their structure, properties and processing; importance of materials properties for containers. Pharmaceutical solvents, fundamentals of solubility and solubilization of drugs. Water treatment processes, sterilization techniques and quality requirements of pharmaceutical water. Parenteral dosage forms and lubricant ophthalmics. Surfactants, micelle formation and colloidal systems. Liquid suspensions and emulsions. Stabilization measures in dosage forms.

### Literature

C.-D. Herzfeldt und J. Kreuter (Hrsg.) *Grundlagen der Arzneiformenlehre*, Springer Verlag, Berlin 1999

H. Leuenberger (Hrsg.) *Pharmazie, Wissenschaftliche Verlagsgesellschaft, Stuttgart 2002*


**Prerequisites / notice**

Language: German and English

### 535-0521-00L

**Pharmacology and Toxicology I**

W 2 credits 2V  

**Abstract**

The two-semester lecture course will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action and therapeutic use of the important classes of drugs. The lectures are intended for students of pharmaceutical sciences.

**Objective**

The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.

**Content**

Topics include disease-relevant macroscopic, microscopic, pathobiological and functional disturbances of specific organs and organ systems. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicology, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered.

**Lecture notes**

Für jede Vorlesung wird ein Skript abgegeben, das eine Zusammenfassung mit den wichtigsten Stichpunkten beinhaltet.

**Literature**

  or

**Comprehensive overview:**


**English version**


The classic textbook in Pharmacology:

Goodman and Gilman’s *The Pharmacological Basis of Therapeutics*  
Laurence Brunton, Bruce Chabner, Bjorn Knollman. 12th edition - 1808 Seiten  

**Prerequisites / notice**

Voraussetzungen: Abschluss Grundstudium
The aim of the lecture course is to provide a solid overview of the science and issues in gene technology and genome science. Topics: Antibody phage technology, protein modification technology, genome projects, genome sequencing, transcriptomics, proteomics and SNP technology. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.

**Objective**

The course will provide a solid overview of the science and issues in gene technology and genome science.

**Content**

1. Antibody phage technology
   - The antibody molecule
   - V genes, CDRs, basics of antibody engineering
   - Principles of phage display
   - Phagemid and phage vectors
   - Antibody libraries
   - Phage display selection methodologies
   - Other phage libraries (peptides, globular proteins, enzymes)
   - Alternative screening/selection methodologies
   - DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
   - Homo- and hetero-dimerization of proteins
   - Chemical modifications of proteins
   - Radioactive labeling of proteins
   - Kinetic association and dissociation constants
   - Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   - Protein cloning and expression
   - Functional Genomics
   - Sequencing genomes and novel sequencing methods
   - Genetic disorders: discovery and pharmaceutical implications
   - Transcriptomics
   - Proteomics
   - Principles of Cancer
   - Principles of Vaccine Development
   - Principles of Gene Therapy

4. Pharmaceuticals: Focus on Discovery
   - Chemical Libraries
   - Protein Therapeutics
   - Consideration on pharmacokinetics and half-life extension

**Lecture notes**

Skript "Gene Technology" by Prof. Dario Neri

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**Pharmaceutical Immunology**

Get Students familiar with basic Immunological concepts of pharmaceutical relevance.

**Objective**

Get Students familiar with basic Immunological concepts of pharmaceutical relevance.

**Content**

Chapters 1 - 11 of the Janeway’s ImmunoBiology, by Kenneth Murphy (8th Edition; Garland).

**Literature**

Janeway's ImmunoBiology, by Kenneth Murphy (8th Edition). Paperback

[www.garlandscience.com]

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**Prerequisites / notice**

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel.

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**Immunology I**

Introduction into structural and functional aspects of the immune system.

**Objective**

Introduction into structural and functional aspects of the immune system.

**Content**

- Basic knowledge of the mechanisms and the regulation of an immune response.
- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

**Lecture notes**

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

**Literature**

Kuby, Immunology, 7th edition, Freeman + Co., New York, 2009

**Prerequisites / notice**

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

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**Cellular Biochemistry (Part I)**

Introduction into structural and functional aspects of the immune system.

**Objective**

Introduction into structural and functional aspects of the immune system.

**Content**

- Basic knowledge of the mechanisms and the regulation of an immune response.
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

**Lecture notes**

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

**Literature**

Kuby, Immunology, 7th edition, Freeman + Co., New York, 2009

**Prerequisites / notice**

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".
Abstract

Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-translational regulation of gene expression.

Lecture notes

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

551-1003-00L

Methods of Biological Analysis

W 3 credits 3G

R. Aebersold, M. Badertscher, K. Weis

529-1042-00

Abstract

Principles of the most important separation techniques and the interpretation of molecular spectra.

Objective

Knowledge of the necessary basics and the possibilities of application of the relevant spectroscopical and separation methods in analytical chemistry.

Content


Lecture notes

A comprehensive script is available in the HCI-Shop. A summary of the part "Spektroskopie" defines the relevant material for the exam.

Literature

- Pretsch E., Bühlmann P., Badertscher M., Spektroskopische Daten zur Strukturaufklärung organischer Verbindungen, fünfte Auflage, Springer-Verlag, Berlin 2010;
- K. Cammann, Instrumentelle Analytische Chemie, Verfahren, Anwendungen, Qualitätssicherung, Spektrum Akademischer Verlag, Heidelberg, 2001;

529-1042-00

Prerequisites / notice

Prerequisites:
- 529-1001-01 V *Allgemeine Chemie I (für Biol./Pharm.Wiss.,)*
- 529-1001-00 P *Allgemeine Chemie I (für Biol./Pharm.Wiss.,)*
- 529-1011-00 G *Organische Chemie I (für Biol./Pharm.Wiss.,)*

551-1295-00L

Introduction to Bioinformatics: Concepts and Applications

W 6 credits 4G

W. Gruissem, K. Bärenfaller, A. Caflisch, G. Captani, J. Fütterer, M. Robinson, A. Wagner

Abstract

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and practice.

Objective

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation
The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects. Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycerol, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation. 


Prerequisites / notice: Some of the lectures are given in the English language.

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**752-2120-00L Consumer Behaviour I**

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

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

**Literature:**
- Principles of Marketing, 16th ed., by Philip Kotler
- Marketing Management, 15th ed., by Philip Kotler and Gary Armstrong
- Marketing Management, 16th ed., by Philip Kotler and Gary Armstrong
- Marketing Management, 17th ed., by Philip Kotler and Gary Armstrong
- Marketing Management, 18th ed., by Philip Kotler and Gary Armstrong

**Notice:**
- Some of the lectures are given in the English language.
- There is no script. Powerpoint presentations will be made available. 

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**752-4005-00L Food Microbiology I**

**Abstract:** This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

**Objective:** The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms. The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.

**Content:**
1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP's of Food Microbiology
2. Overview of Microorganisms in Foods
   2.1 Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
   3.7. Dry Foods
   4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

**Lecture notes:** Electronic copies of the presentation slides (PDF) will be made available for download. 

**Literature:**
- FoodMicrobiology.pdf
- FoodMicrobiology-latest.pdf
- FoodMicrobiology-complete.pdf
- FoodMicrobiology-updated.pdf
- FoodMicrobiology-final.pdf
- FoodMicrobiology-final2.pdf

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**752-6001-00L Introduction to Nutritional Science**

**Abstract:** This course introduces basic concepts of micro- and macronutrient nutrition. Macronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.

**Objective:** To introduce the students to the both macro- and micronutrients in relation to food and metabolism.

**Content:** The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeostasis are emphasized.

**Lecture notes:** There is no script. Powerpoint presentations will be made available. 

**Literature:**
- Elnadif I & Leitzmann C: Ernährung des Menschen
- UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004

- Garrow JS and James WPT: Human Nutrition and Dietetics
- Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

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**752-6301-00L Selected Topics in Physiology Related to Nutrition**

**Abstract:** Gives the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand.
Objective
Some basic knowledge in physiology is recommended for this course, which revisits important physiological topics, emphasizing their relation to nutrition. The aim is to give the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand. For students with a background in medicine, pharmacy or biology, the course is useful as a review of previously acquired knowledge. Major topics are basic neuroanatomy and neurophysiology; general endocrinology; the physiology of taste and smell; nutrient digestion and absorption; intermediary metabolism and energy homeostasis; and some aspects of cardiovascular physiology and water balance.

752-6403-00L Nutrition and Performance

Abstract
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

Objective
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

Content
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture notes
Lecture slides and required handouts will be available on the ETH website.

Literature
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Prerequisites / notice
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English
It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

853-0033-00L Leadership I

Abstract
The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

Objective
The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

Prerequisites / notice
The 1-hour written exam will take place during the last lecture in the semester.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-HEST.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Sport Practical

Assessments

Sport Practical Basic Education

Sport Practical Advanced Education

Health Sciences and Technology Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
#### Educational Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W DZ)</td>
<td>L</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 20.</td>
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<tr>
<td></td>
<td>The successful participation in EW1 (&quot;Human Learning&quot;) and EW2 (&quot;Designing Learning Environments for School&quot;) is recommended, but not a mandatory prerequisite.</td>
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<tr>
<td>Abstract</td>
<td>In this class, students will learn concepts and skills for coping with psychosocial demands of teaching</td>
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<tr>
<td>Objective</td>
<td>Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.</td>
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<td></td>
<td>(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).</td>
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<td>(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).</td>
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<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects W</td>
<td>L</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td>Abstract</td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<tr>
<td>Objective</td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<tr>
<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence W</td>
<td>L</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td>Abstract</td>
<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<tr>
<td>Objective</td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td></td>
<td>- Getting to know intelligence tests</td>
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<tr>
<td></td>
<td>- Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science W</td>
<td>L</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Ziegler</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td>Abstract</td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<tr>
<td>Objective</td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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</tbody>
</table>

see Educational Science TC

#### Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-8001-00L</td>
<td>Didactics of Health Sciences and Technology I O</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>S. Maurer</td>
</tr>
<tr>
<td></td>
<td>Only for Health Sciences and Technology TC students.</td>
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<tr>
<td></td>
<td>Enrolment at the earliest possible with the lecture 851-0240-00 &quot;Human Learning&quot;</td>
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<tr>
<td>Abstract</td>
<td>In this course students learn the principles and techniques of teaching singular lessons, based on scientific knowledge about learning. The aim is to plan, realize, evaluate and reflect lessons effectively and efficiently.</td>
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</tbody>
</table>
Objective
- Students know how to prepare, conduct and reflect a single lesson based on educational requirements.
- Students take the learning goals as a starting point considering previous knowledge as well as the professional environment and the ambitions of the learners.
- Students apply the basic teaching techniques of their subject area in a sensible way and know how to appropriately arrange the phases of learning.
- Students know how to simplify and present complex technical contents of their subject area.

376-8008-00L Teaching Internship Including Examination Lessons Health Sciences and Technologie

Only for Health Sciences and Technology TC students.

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

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

Objective
- Students know how to simplify and present complex technical contents of their subject area.
- Students take the learning goals as a starting point considering previous knowledge as well as the professional environment and the ambitions of the learners.
- Students apply the basic teaching techniques of their subject area in a sensible way and know how to appropriately arrange the phases of learning.

Teaching Internship Including Examination Lessons O 6 credits 13P S. Maurer

Health Sciences and Technologie

Only for Health Sciences and Technology TC students.

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

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

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

Further Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-8011-00L</td>
<td>Mentored Work Subject Didactics Health Sciences and Technologie</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>S. Maurer</td>
</tr>
</tbody>
</table>

Abstract
The mentored paper is designed to bring together the findings from the FD1 and the FD2. By using various teaching techniques and methods a semester plan, which is based on various curricula will be elaborated for a given topic.

Objective
1. The students have planned a curriculum for a semester course.
2. Students reflect on formative and summative ways such a teaching unit to examine and implement parts of it.
3. The students have implemented parts of the semester curriculum.
4. The students deal with the question to what extend teaching techniques, teaching methods but also sequences of self-study must be involved in the planning.

Health Sciences and Technology TC - Key for Type

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

Key for Hours

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

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
#### Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0390-00L</td>
<td>Translational Science for Health and Medicine</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>J. Goldhahn, C. Wolfrum</td>
</tr>
</tbody>
</table>

**Abstract**

Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

**Objective**

After completing this course, students will be able to understand:

- Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

**Content**

What is translational science and what is it not?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?

**Prerequisites / notice**

How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

#### Electives

##### Electives Courses I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0221-00L</td>
<td>Contemporary Problems of Neural Control of Movement  ■</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>N. Wenderoth</td>
</tr>
</tbody>
</table>

**Number of participants limited to 20.**

**Abstract**

Students read, present and discuss seminal papers in the field of Neural Control of Movement and Motor Learning.

**Objective**

The goal of this course is to nurture and develop independent thinking which is a vital component of personal and professional development. Students will critical evaluate academic papers, present logical arguments, source reliable information and design thought experiments to solve problems relevant to the neural control of behavior.

**Prerequisites / notice**

Students are required to have successfully completed the course "Neural control of movement and motor learning" and to have basic knowledge of applied statistics. Self-study material will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week (open book). Passing this test is a requirement for continuing the course. Students will be required to write essays, give presentations and participate in discussions on a regular basis. Assessment will be made on the basis of the complete aforementioned practical work.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0223-00L</td>
<td>Advanced Topics in Exercise Physiology ■</td>
<td>W</td>
<td>2</td>
<td>1V</td>
<td>C. Spengler, F. Gabe Beltrami</td>
</tr>
</tbody>
</table>

**Abstract**

In this course, students read, present and discuss seminal publications in the area of exercise physiology. The focus lies on critical analysis of scientific content, conceptual as well as ethical aspects of publications. Students are trained in the most common scientific presentation techniques such as oral and poster presentations.

**Objective**

Students gain further knowledge and a deeper understanding of concepts in exercise physiology. Emphasis is put on critical analysis and discussion of scientific publications as well as on improving scientific presentation skills.

**Prerequisites / notice**

Successful completion of the Exercise Physiology Course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0225-00L</td>
<td>Physical Activities and Health</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>E. de Bruin</td>
<td>Core texts for this course are:</td>
</tr>
</tbody>
</table>

**Abstract**

This course introduces/explores the complex relationship between physical activity, sedentary behavior and health. It will discuss the evolution of current physical activity recommendations. It will examine the current evidence base that has informed physical activity recommendations and that identified physical activity as a key modifiable lifestyle behavior contributing to disease and mortality.

**Objective**

On completion of this course students will be able to demonstrate:

1. knowledge of and critical awareness of the role of physical activity and sedentary behavior in the maintenance of health and the aetiology, prevention and treatment of disease.
2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases
3. awareness of current national and international physical activity policies and how these impact on global challenges

**Content**

Introduction to Physical Activity for Health, including sedentary behavior
- Physical activity epidemiology; concepts principles and approaches
- Physical activity and all cause morbidity and mortality
- Physical activity and chronic disease; Coronary heart disease, diabetes, bone health, cancer and obesity
- Physical activity and brain health
- Physical activity and sedentary behavior recommendations
- Population prevalence of physical activity and sedentary behavior
- Physical activity policies
- Physical activity assessment

**Literature**

Core texts for this course are:


Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity
Prerequisites / notice
From the BSc-course the following book is recommended: ‘Essentials of strength training and conditioning’ T. Baechle, R. Earle (3rd Edition)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-1651-00L</td>
<td>Clinical and Movement Biomechanics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>S. Lorenzetti, R. List, N. Singh</td>
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<tr>
<td></td>
<td>Measurement and modeling of the human movement during daily activities and in a clinical environment.</td>
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<td></td>
<td>The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.</td>
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<td></td>
<td>This course includes ethical considerations, measurement techniques, clinical testing, accessing movement data and anaylsis as well as modeling with regards to human movement.</td>
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<tr>
<td>752-6101-00L</td>
<td>Nutrition and Chronic Disease (HS)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
</tr>
<tr>
<td></td>
<td>To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<td>To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.</td>
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<td></td>
<td>The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<tr>
<td></td>
<td>There is no script. Powerpoint presentations will be made available on-line to students.</td>
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<td>To be provided by the individual lecturers, at their discretion.</td>
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<td>No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.</td>
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</table>

#### Elective Courses II

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers** |
---|---|---|---|---|---|
151-0104-00L | Uncertainty Quantification for Engineering & Life Sciences | W | 4 | 3G | J. Beck, P. Kounoutsakos |
| | **Abstract** | | | | Number of participants limited to 60. |
| | **Objective** | | | | Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology. |
| | **Content** | | | | Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis. |
| | **Literature** | | | | The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderj Sivia as well as on class notes and related literature that will be distributed in class. |
| | **Prerequisites / notice** | | | | Fundamentals of Probability, Fundamentals of Computational Modeling |
| 227-0385-10L | Biomedical Imaging | W | 6 | 5G | S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin |
| | **Abstract** | | | | Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques. |
| | **Objective** | | | | To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts. |
| | **Content** | | | | - X-ray imaging - Computed tomography - Single photon emission tomography - Positron emission tomography - Magnetic resonance imaging - Ultrasound/Doppler imaging |
| | **Literature** | | | | Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011 |
| | **Prerequisites / notice** | | | | Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming |
| 227-0386-00L | Biomedical Engineering | W | 4 | 3G | J. Vårøe, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong |
| | **Abstract** | | | | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined. |
| | **Objective** | | | | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations. |
Image Analysis and Computer Vision

**Abstract**

**Objective**
Overview of the most important concepts of image formation, perception, and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

**Content**
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

**Literature**
Kenney/Wilmore/Costill: Physiology of Sport and Exercise, Human Kinetics

**Lecture notes**
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

**Prerequisites**
Course material Script, computer demonstrations, exercises and problem solutions

**Prerequisites / notice**
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

**Work Design and Organizational Change**

**Abstract**
Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.

**Objective**
- Know effects of work design on competence, motivation, and well-being
- Understand links between design of individual jobs and work processes
- Know basic processes involved in systematic organizational change
- Understand the interaction between organization and technology and its impact on organizational change
- Understand relevance of work design for company performance and strategy
- Know and apply methods for analyzing and designing work

**Content**
- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterion
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

**Literature**
A list of required readings will be provided at the beginning of the course.

**Technology Entrepreneurship**

**Abstract**
Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.

**Objective**
This course covers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

**Content**
See course website

**Lecture notes**
Lecture slides and case material

**Laboratory Course in Exercise Physiology**

**Abstract**
Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

**Objective**
Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today's Sports Medicine.

**Content**
Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

**Lecture notes**
Tutorial on Laboratory Experiments in Exercise Physiology
(Editor: Exercise Physiology Lab)

**Literature**
Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg

Kenney/Wilmore/Costill: Physiology of Sport and Exercise, Human Kinetics
History of Sports

Comprehension for development and changes of sports from the ancient world to the present. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Objective
Understanding for the development and adaptation of sports from the ancient world to present times.

Content

Lecture notes
Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Literature

Movement and Sport Biomechanics

Learning to view the human body as a (bio-) mechanical system. Making the connections between everyday movements and sports activity with injury, discomfort, prevention and rehabilitation.

Objective
Students are able to describe the human body as a mechanical system. They analyse and describe human movement according to the laws of mechanics.

Content
Movement- and sports biomechanics deals with the attributes of the human body and their link to mechanics. The course includes topics such as functional anatomy, biomechanics of daily activities (gait, running, etc.) and looks at movement in sport from a mechanical point of view. Furthermore, simple reflections on the loading analysis of joints in various situations are discussed. Additionally, questions covering the statics and dynamics of rigid bodies, and inverse dynamics, relevant to biomechanics are investigated.

Exercise Physiology

This course provides an overview over molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interactions of the different systems influencing factors, e.g. genetics, gender, age, altitude/depth, heat/cold, with respect to performance and health.

Objective
The aim of this course is to understand molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interaction of the different systems regarding health-relevant aspects and performance in healthy people and persons with selected diseases. Furthermore, students will understand the influence of genetics, gender, age, altitude/depth, heat and cold on the named factors.

Content
History of Exercise Physiology, research methods, fibertype heterogeneity and its functional significance, neural control of muscle force, molecular and cellular mechanisms of muscle adaptation to resistance, endurance and stretching exercise, interindividual variability in the response to training, cardiorespiratory and metabolic responses to acute and chronic exercise, sex differences relevant to exercise performance, exercise in hot and cold environment, children and adolescents in sport and exercise, exercise at altitude and depth, aging and exercise performance, exercise for health, exercise in the context of disease.

Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)

Anatomy and Physiology I + II

Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Objectives
- Understanding for the development and adaptation of sports from the ancient world to present times.

Literature
- Ein Skript für die aktuelle Veranstaltung wird abgegeben.

History of Sports

Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Objective
Understanding for the development and adaptation of sports from the ancient world to present times.

Content

Lecture notes
Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Literature

Prerequisites / notice
- Anatomy and physiology classes and lab course in physiology successfully completed (BWS students please contact C. M. Spengler)
- Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)

Sport Pedagogy

Central aspects of sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

Objective
To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Content
- Inhaltliche Schwerpunkte der Vorlesung sind:
  - Einführung in die Sportpädagogik
  - Bedeutung des Sports im Kindes- und Jugendalter
  - Leistungssport im Kindes- und Jugendalter
  - Pädagogische Perspektiven des Sportunterrichts in der Schule
  - Ein zeitgemäßer Schulsport
  - Bewegungskulturelle Bildung: Bewegungserziehung, Spielerziehung

Lecture notes
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

Sociology of Sport

These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

Objective
The lectures set out to:
- present the different dimensions, functions and interrelationships of present-day sport
- provide an introduction to the central theories and models of (sport) sociology
- show how far sport reflects society and how it changes and becomes more differentiated in the process
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

Content
- Sport and social change: developments and trends
- The economy and the media: dependencies, consequences, scandals
- Social inequalities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

Lecture notes
Selected materials for the lecture are available under www.LSSFB.ch --> Lehre
Applications of Cybernetics in Ergonomics


A detailed program with additional references will be delivered at the beginning of the lecture.

376-1117-00L  Sport Psychology  W  2 credits  2V  H. Gubelmann

Abstract
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

Objective
Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

Content
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

Literature

376-1177-00L  Human Factors I  W  2 credits  2V  M. Menozzi Jäckli, R. Boutellier, R. Huang, M. Siegrist

Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature

376-1179-00L  Applications of Cybernetics in Ergonomics  W  1 credit  1U  M. Menozzi Jäckli

Abstract
Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-modal interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective
To learn and practice cybernetics principles in interface designs and product development.

Content
- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodation/vergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines

Literature

376-1219-00L  Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions  W  3 credits  2V  R. Riener, R. Gassert, L. Marchal Crespo

Abstract
Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
- Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature
Introductory Books:

Prerequisite / notice
Target Group:
- Students of higher semesters and PhD students of
  - D-MAVT, D-ITET, D-INFK, D-HEST
  - Biomedical Engineering, Robotics, Systems and Control
  - Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome

376-1714-00L Biocompatible Materials W 4 credits 3G K. Maniura, J. Möller, M. Zenobi-Wong
Application of MATLAB in the Human Movement

Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).

Objective

The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Prerequisites

A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

Lecture notes

Handouts can be accessed online.

Handouts provided during the classes and references therein.

(available online via ETH library)

Literature

Handouts provided during the classes and references therein.

376-1720-00L Application of MATLAB in the Human Movement

Abstract

Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).

Objective

Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.

Content

Drawbacks of Excel; Possibilities in MATLAB; Import of several data formats; Plot of one and more signals; Removing of an offset and filtering of data based on self-written functions; Normalisation and parametrisation of data; Reliability; Interpolation, Differentiation and Integration in MATLAB.

Literature

During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.

Prerequisites

A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

376-1722-00L Spinal Cord Injury and Exercise

Abstract

Intensive discussion concerning complications of a spinal cord injury and their consequences on trainability and exercise performance of persons sitting in a wheelchair. Overview on the clinical application of exercise testing as well as on the implementation of sport scientific findings to optimise performance of spinal cord injured subjects in rehabilitation and elite sports.

Objective

Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

Content

The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury

Literature

General literature:

G.A. Zäh, H. G. Koch
Paraplegie - ganzheitliche Rehabilitation
Karger-Verlag, 2006
ISBN 3-8055-7980-2

V. Goosey-Tolfrey
Wheelchair sport: A complete guide for athletes, coaches and teachers
Human Kinetics, 2010

Y.C. Vanlandewijck, W.R. Thompson
The Paralympic Athlete
Wiley-Blackwell, 2011
ISBN 978-1-4443-3404-3

Liz Broad
Sports Nutrition for Paralympic Athletes
CRC Press 2014

Prerequisites / notice

Voraussetzung: Vorlesung Anatomie/Physiologie besucht!

376-1974-00L Colloquium in Biomechanics

Abstract

Current topics in biomechanics presented by speakers from academia and industry. Getting insight into actual areas and problems of biomechanics.

Objective

Trauma Biomechanics

Abstract

Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

Objective

Introduction to the basic principles of trauma biomechanics.

Content

This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics.

K.U. Schmitt

Class material will be distributed using the moodle platform.

R. Heusser
S. Mettler

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Students are able to assess human movement using different methods of movement analysis.

During the course students get acquainted with different methods of movement analysis such as: functional, morphological, clinical, mechanical, and others.

Based on practical examples, these methods are used and compared. The examples range from sport, everyday movement and therapy, such as hockey, gymnastics, acrobatics, badminton, gait / running and strength training. In the first phase of the class, the different approaches are applied. In the second phase, small teams are working on individual projects. These will be discussed and presented in plenum.

A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

Handouts can be downloaded.


A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture. There will be some mandatory as well as voluntary readings.

Handouts can be downloaded.


Epidemiology and Prevention

Number of participants limited to 15.

Students are able to assess human movement using different methods of movement analysis.

Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

The course offers an introduction to key principles of public health. Students get acquainted with the concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

To critically assess scientific literature
- to interpret the results of epidemiological studies
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individual as well as our society in relation to the obesity epidemic

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventative measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

Language of the course is English

Handouts are provided to students in the classroom.

The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

To critically assess scientific literature
- to interpret the results of epidemiological studies
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individual as well as our society in relation to the obesity epidemic

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventative measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

Language of the course is English

Handouts are provided to students in the classroom.

The module introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.
Prerequisites / notice

- General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.
- The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).
- Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

**Major in Human Health, Nutrition and Environment**

**Compulsory Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.

**Objective**
- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising of academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

**Content**
Topics are offered in the domains of the major ‘Human Health, Nutrition and Environment’ covering ‘Public Health’, ‘Infectious Diseases’, ‘Nutrition and Health’ and ‘Environment and Health’.

**Lecture notes**
Guidelines will be handed out in the beginning.

**Literature**

- Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.
- After completing this course, students will be able to understand:
  - Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)
- What is translational science and what is it not?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences
- Positive and negative examples will be illustrated by distinguished guest speakers.

**Electives**

**Elective Courses I**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0629-00L</td>
<td>Applied Biostatistics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Müller</td>
</tr>
</tbody>
</table>

**Abstract**
Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.

**Objective**
Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the suits.

**Content**

**Lecture notes**
see teaching document repository

**Literature**


**Prerequisites / notice**
The statistical package R will be used in the exercises. If you are unfamiliar with R, I highly recommend the online R course etutor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Eichholzer</td>
</tr>
</tbody>
</table>

**Abstract**
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

**Objective**
Students are able
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

752-6151-00L Public Health Concepts

Objective
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Content
Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Lecture notes
Handouts are provided to students in the classroom.

Language of the course is english

ELECTIVE COURSES II

MODULE: INFECTIOUS DISEASES

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 551-0223-00L | Immunology III                     | W    | 4    | 2V    | M. Kopf, M. Bachmann, J. Kisielow, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spörrir
| | Abstract                           |      |      |       | This course provides a detailed understanding of
| |                                   |      |      |       | - development of T and B cells
| |                                   |      |      |       | - the dynamics of a immune response during acute and chronic infection
| |                                   |      |      |       | - mechanisms of immunopathology
| |                                   |      |      |       | - modern vaccination strategies
| |                                   |      |      |       | Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.
| | Objective                         |      |      |       | Obtain a detailed understanding of
| |                                   |      |      |       | - the development, activation, and differentiation of different types of T cells and their effectormechanisms during immune responses, - Recognition of pathogenic microorganisms by the host cells and molecular events thereafter, - events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
| |                                   |      |      |       | - Optimization of B cell responses by intelligent design of new vaccines
| |                                   |      |      |       | o Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
| |                                   |      |      |       | o NK T cells and responses to lipid antigens
| |                                   |      |      |       | o Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
| |                                   |      |      |       | o Overview of cytokines and their effector function
| |                                   |      |      |       | o Co-stimulation (signals 1-3)
| |                                   |      |      |       | o Dendritic cells
| |                                   |      |      |       | o Evolution of the "Danger" concept
| |                                   |      |      |       | o Cells expressing Pattern Recognition Receptors and their downstream signals
| |                                   |      |      |       | o T cell function and dysfunction in acute and chronic viral infections
| | Literature                        |      |      |       | Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=998
| | Prerequisites / notice            |      |      |       | Immunology I and II
| 551-1171-00L | Immunology: from Milestones to Current Topics | W    | 4    | 2S    | B. Ludewig, M. Kopf, A. Oxenius, University lecturers
| | Abstract                           |      |      |       | Milestones in Immunology: on old concepts and modern experiments
| | Objective                         |      |      |       | The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.
| |                                   |      |      |       | Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunity.
| | Lecture notes                     |      |      |       | Original and review articles will be distributed by the lecturer.
| | Literature                        |      |      |       | Litteraturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app2.let.ethz.ch/course/view.php?id=1002
| 636-0007-00L | Molecular Evolution, Phylogenetics and Phylodynamics | W    | 4    | 3G    | T. Stadler
| | Abstract                           |      |      |       | The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.
Objective
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:

- models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:

- epidemiology
- pathogen evolution
- macroevolution of species

Content
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. Finally, we introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution will provide insight into the evolution and ecology of different species clades.

Lecture notes
Slides of the lecture will be available online.

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics.

701-0283-01L Seminar in Evolutionary Ecology of Infectious Diseases

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

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

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

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

752-4009-00L Molecular Biology of Foodborne Pathogens

Abstract
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature
Recommendations will be given in the first lecture

Prerequisites / notice
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

Module: Nutrition and Health

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<tr>
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<th>Title</th>
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<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann, V. Visschers</td>
</tr>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
</tbody>
</table>

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 708 of 1432
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- **Probiotics and Prebiotics**: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- **Bioprotective Cultures and Antimicrobial Metabolites**: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- **Legal and Protection Issues Related Functional Foods**

- **Industrial Biotechnology of Flavor and Taste Development**

- **Safety of Food Starter Cultures and Probiotics**

Students will be required to complete a group project on food products and ingredients with probiotics or from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

**Lecture notes**
Copy of the power point slides from lectures will be provided.

**Literature**
A list of references will be given at the beginning of the course for the different topics presented during this course.

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**752-6101-00L Nutrition and Chronic Disease (HS)**

**Abstract**
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes**
There is no script. Powerpoint presentations will be made available on-line to students.

**Literature**
To be provided by the individual lecturers, at their discretion.

**Prerequisites / notice**
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

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**752-6402-00L Nutrigenomics**

**Abstract**
Nutrigenomics - toward personalized nutrition?
Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

**Objective**
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics

**Content**
- For the content of the script see section "Skript" below
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.

**Lecture notes**
The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

- **Module A**
  From biochemical nutrition research to nutrigenomics
- **Module B**
  Nutritional genomics
- **Module C**
  Nutrigenetics
- **Module D**
  Nutri-epigenomics
- **Module E**
  Transcriptomics in nutrition research
- **Module F**
  Proteomics in nutrition research
- **Module G**
  Metabolomics in nutrition research
- **Module H**
  Nutritional systems biology
- **Module I**
  Individualized nutrition - opportunities and challenges

**Literature**
No extra reading requested. Most slides in the lecture are referenced with web adresses.

**Prerequisites / notice**
Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

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### Module: Environment and Health

**Number**  **Title**  **Type**  **ECTS**  **Hours**  **Lecturers**
---
701-1341-00L Water Resources and Drinking Water  W  3 credits  2G  S. Hug, M. Berg, F. Hammes, U. von Gunten
Abstract The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes Handouts will be distributed

Literature Will be mentioned in handouts

► Major in Health Technologies

►► Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>376-0300-00L</td>
<td>Translational Science for Health and Medicine</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>J. Goldhahn, C. Wolfum</td>
</tr>
</tbody>
</table>

Abstract Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

Objective After completing this course, students will be able to understand:
Principles of translational science (including project planning, ethics application, basics of resource management and interdiscip
lar communication)

Content What is translational science and what is it not?
How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources

How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

►► Electives

►►► Elective Courses I

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<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>376-1103-00L</td>
<td>Frontiers in Nanotechnology</td>
<td>W</td>
<td>4</td>
<td>4V</td>
<td>V. Vogel, further lecturers</td>
</tr>
</tbody>
</table>

Abstract Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

Objective Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nanochemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/hers own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Content Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Lecture notes All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

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<tr>
<th>Number</th>
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<tr>
<td>376-1219-00L</td>
<td>Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Riesen, R. Gassett, L. Marchal Crespo</td>
</tr>
</tbody>
</table>

Abstract Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.
Content

- Introduction, problem definition, overview
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
  - Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
  - Rehabilitation and use of kinesthetic and tactile function
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
  - Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
- Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
  - Brain stimulation and recording
- Rehabilitation and use of kinesthetic and tactile function
  - Brain-Computer Interfaces

Literature

Introductory Books:


Selected Journal Articles and Web Links:

Prerequisites / notice

- VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html
- Target Group:
  - Students of higher semesters and PhD students of
  - D-MAVT, D-ITET, D-INFK, D-HEST
  - Biomedical Engineering, Robotics, Systems and Control
  - Medical Faculty, University of Zurich
  - Students of other departments, faculties, courses are also welcome

401-0629-00L Applied Biostatistics W 4 credits 3G M. Müller

Abstract Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.

Objective Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the sults.


Lecture notes see teaching document repository


Prerequisites / notice The statistical package R will be used in the exercises. If you are unfamiliar with R, I highly recommend the online R course etutoR.

Elective Courses II

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulilakos, A. Ferrari</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.</td>
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<tr>
<td>Objective</td>
<td>Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.</td>
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<tr>
<td>Content</td>
<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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<tr>
<td>Lecture notes</td>
<td>Script as well as additional material in the form of hand-outs will be distributed.</td>
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<tr>
<td>Literature</td>
<td>Lecture notes and references therein.</td>
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<tbody>
<tr>
<td>151-0600-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
<tr>
<td>Abstract</td>
<td>Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
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<tr>
<td>Objective</td>
<td>The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.</td>
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<tr>
<td>Content</td>
<td>Main topics of the course include: - Scaling laws at micro/nano scales - Electrostatics - Electromagnetism - Low Reynolds number flows - Observation tools - Materials and fabrication methods - Applications of biomedical microrobots</td>
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<tr>
<td>Lecture notes</td>
<td>The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The lecture will be taught in English.</td>
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<tbody>
<tr>
<td>227-0391-00L</td>
<td>Medical Image Analysis</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. C. Cattin, M. A. Reyes Aguirre</td>
</tr>
<tr>
<td>Abstract</td>
<td>It is the objective of this lecture to introduce the basic concepts used in Medical Image Analysis. In particular the lecture focuses on shape representation schemes, segmentation techniques, and the various image registration methods commonly used in Medical Image Analysis applications.</td>
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<tr>
<td>Objective</td>
<td>This lecture aims to give an overview of the basic concepts of Medical Image Analysis and its application areas. Basic knowledge of computer vision would be helpful.</td>
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<tr>
<td>Prerequisites / notice</td>
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<tbody>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6 credits</td>
<td>3V+1U</td>
<td>G. Székely, O. Göksel, L. Van Gool</td>
</tr>
<tr>
<td>Objective</td>
<td>Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.</td>
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<tr>
<td>Content</td>
<td>The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Course material Script, computer demonstrations, exercises and problem solutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Stampapanoni, K. S. Mader</td>
</tr>
</tbody>
</table>

The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Objective
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes
Available online

Literature
Will be indicated during the lecture.

227-0969-00L Methods & Models for fMRI Data Analysis  W  6 credits  3V  K. E. Stephan
Abstract
This course teaches methods and models for fMRI data analysis, covering all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, statistical inference, multiple comparison corrections, event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data.

Objective
To obtain in-depth knowledge of the theoretical foundations of SPM and DCM and of their application to empirical fMRI data.

Content
This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in psychiatry, neurology and neuroeconomics.

252-0523-00L Computational Biology  W  6 credits  3V+2U  G. H. Gonnet
Abstract
Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

Objective
Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

Content
This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

327-0505-00L Surfaces, Interfaces and their Applications I  W  3 credits  2V+1U  N. Spencer, M. P. Heuberger, L. Isa
Abstract
After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.

Objective
To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

Content
Introduction to Surface Science
Physical Structure of Surfaces
Surface Forces (static and dynamic)
Adsorbates on Surfaces
Surface Thermodynamics and Kinetics
The Solid-Liquid Interface
Electron Spectroscopy
Vibrational Spectroscopy on Surfaces
Scanning Probe Microscopy
Introduction to Tribology
Introduction to Corrosion Science

Lecture notes
Script Download: https://www.surface.mat.ethz.ch/education/courses/surfaces_interfaces_and_their_applications_i

Literature
Script (20 CHF)

Prerequisites / notice
Chemistry:
General undergraduate chemistry including basic chemical kinetics and thermodynamics

Physics:
General undergraduate physics including basic theory of diffraction and basic knowledge of crystal structures

363-0790-00L Technology Entrepreneurship  W  2 credits  2V  U. Claesson, P. Baschera, F. Hacklin
Abstract
Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.

Objective
This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

Content
See course website

Lecture notes
Lecture slides and case material

376-1177-00L Human Factors I  W  2 credits  2V  M. Menozzi Jäckli, R. Boutellier,
Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature

Table 1

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>ECTS</th>
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<tr>
<td>376-1179-00L</td>
<td>Applications of Cybernetics in Ergonomics</td>
<td>W</td>
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<tr>
<td>376-1279-00L</td>
<td>Virtual Reality in Medicine</td>
<td>W</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>376-1351-00L</td>
<td>Micro/Nanotechnology and Microfluidics for Biomedical Applications</td>
<td>W</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>376-1504-00L</td>
<td>Physical Human Robot Interaction (pHRI)</td>
<td>W</td>
<td>4</td>
<td>2+2</td>
</tr>
</tbody>
</table>

Abstract
Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-modal interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective
To learn and practice cybernetics principles in interface designs and product development.

Content
- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodationvergence crosslink function
- Cross-link models in neurobiology; the ocular motor control system
- Human performance in optimization of production lines

Literature

Abstract
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will deliver the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of higher semesters and PhD students of
- D-HEST, D-MAVT, D-ITET, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich

Literature

Prerequisites / notice
The course language is English.
Basic experience in Information Technology and Computer Science will be of advantage.
More details will be announced in the lecture.

Abstract
This course is an introduction to techniques in micro/nanotechnology and to microfluidics. It reviews how many familiar devices are built

Objective
The main objective of the course is to introduce micro/nanotechnology and show them how micro/nanotechnology pervades throughout life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how

Content
Mostly formal lectures (2 × 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).

Prerequisites / notice
Nanotech center and lab visit at IBM would be mandatory, as well as attending the student project presentations.

Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptic, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.
Objective

The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force-control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical-human-robot interaction, laboratory sessions and lab visits.

Students will attend laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://edu.haptics.ethz.ch/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/visual coupling, friction, damping, time delays, sampling rate, static quantization, etc.) during rendering of different mechanical properties.

Lecture notes

Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Literature


Prerequisites / notice

Notice:

The registration is limited to 26 students
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/cphri

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 715 of 1432
Abstract
Measurement and modeling of the human movement during daily activities and in a clinical environment.

Objective
The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

Content
This course includes ethical considerations, measurement techniques, clinical testing, accessing movement data and analytics as well as modeling with regards to human movement.

376-1985-00L

Trauma Biomechanics

W 4 credits 2V+1U

K.U. Schmitt, M. H. Muser

Abstract
Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

Objective
Introduction to the basic principles of trauma biomechanics.

Content
This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real-world examples mainly from automobile safety are used to augment lecture material.

Literature

Literature
http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

402-0674-00L

Physiology in Medical Research: From Atoms to Cells

W 6 credits 2V+1U

B. K. R. Müller

Abstract
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epifluorescence growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theory are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

Objective
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

Further references will be provided in the course.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

535-0423-00L

Drug Delivery and Drug Targeting

W 2 credits 2V

J.C. Leroux, D. Brambilla

Abstract
The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

Objective
The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. This focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

Content
The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Literature


551-0317-00L

Immunology I

W 3 credits 2V

A. Ozemen, M. Kopf

Abstract
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.
Introduction into structural and functional aspects of the immune system.

Basic knowledge of the mechanisms and the regulation of an immune response.

- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histoincompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien".

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, C. M. Azzalin, B. Kommann, M. Peter

Abstract

Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecture notes

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature


Prerequisites / notice

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

636-0003-00L Biological Engineering and Biotechnology W 6 credits 3V M. Fussenegger

Abstract

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to Development of Biological Weapons?
6. From Target To Market. An Antibody's Journey From Cell Culture to Biological and Malign Applications. Do Life Sciences Enable the Functional Food. Enjoy your Meal!

Lecture notes

Handout during the course.

Major in Molecular Health Sciences

Compulsory Courses

Number 376-0300-00L
Title Translational Science for Health and Medicine

Abstract

Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

Objective

After completing this course, students will be able to understand:

- Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

ECTS 3

Lecturers J. Goldhahn, C. Wolfrum
What is translational science and what is it not?

How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
How to measure success?
- Outcome variables
- Improving the translational process

Challenges of communication?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

Electives
Elective Courses I

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<tr>
<th>Number</th>
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<th>Type</th>
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<tr>
<td>376-0205-00L</td>
<td>Molecular Disease Mechanisms I</td>
<td>W</td>
<td>6</td>
<td>4V</td>
<td>C. Wolfrum, C. Claudio, M. Ristow, M. Stoffel, A. Wutz, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

Abstract
The mechanisms of disease development will be studied. Main topics will be: Genetic regulation of disease development with a focus on monogenic and polygenic forms. In addition the methods used in elucidating genetic components in disease progression will be discussed. Ageing and development associated disease progression including the underlying molecular mechanisms.

Objective
To understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components.

Elective Courses II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>551-0223-00L</td>
<td>Immunology III</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Kopf, M. Bachmann, J. Kieseler, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spörri</td>
</tr>
</tbody>
</table>

Abstract
This course provides a detailed understanding of
- development of T and B cells
- the dynamics of a immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies
Key experimental results will be shown to help understanding how immunological textbook knowledge has evolved.

Objective
Obtain a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effector mechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines

Content
- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

Literature
Documents of the lectures are available for download at:
https://moodle-app2.let.ethz.ch/course/view.php?id=998

Prerequisites / notice
- Immunology I and II

551-0317-00L  | Immunology I            | W    | 3    | 2V    | A. Oxenius, M. Kopf |

Abstract
Introduction into structural and functional aspects of the immune system.
Basic knowledge of the mechanisms and the regulation of an immune response.

Objective
Introduction into structural and functional aspects of the immune system.
Basic knowledge of the mechanisms and the regulation of an immune response.

Content
- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Lecture notes
Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

Prerequisites / notice
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

551-0512-00L  | Current Topics in Molecular and Cellular Neurobiology | W    | 2    | 1S    | U. Suter |

Number of participants limited to 8.
The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

- By the end of this module, each student should be able to:
  - recognize the universal principles underlying the development of different animal body plans.
  - explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
  - relate changes in gene structure or function to evolutionary changes in animal development.

- Key skills:
  - By the end of this module, each student should be able to:
    - present and discuss a relevant evolutionary topic in an oral presentation
    - select and integrate key concepts in animal evolution from primary literature
    - participate in discussions on topics presented by others

By the end of this module, each student should be able to:

- relate changes in gene structure or function to evolutionary changes in animal development.
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Prerequisites:

- 529-1003-00L "Methods of Biological Analysis"
- 529-1011-00 "Organische Chemie I (für Biol./Pharm.Wiss.)"
- 529-1001-00 "Allgemeine Chemie I (für Biol./Pharm.Wiss.)"

Lecture notes

A comprehensive script is available in the HCI-Shop. A summary of the part "Spektroskopie" defines the relevant material for the exam.

Prerequisites / notice

You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

551-1003-00L Methods of Biological Analysis

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO336

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective

By the end of this module, each student should be able to:

- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Content

Based on the literature, the students will present an overview of animal development. The students will analyze, in an oral presentation, a paper published in the recent literature. The content of the presentation will be based on the specific topics chosen for the given week and the changes in animal development.

Lecture notes

Presentations will be made available after the seminars.

Literature

We cover a range of themes related to development and neurobiology. Before starting your preparations, check with Jorge Pereira (jorge.pereira@biol.ethz.ch), who helps you with finding an appropriate paper.

Prerequisites / notice

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

551-1057-00L From DNA to Diversity (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO336

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Objective

You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

Content

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

Lecture notes

Presentations will be made available after the seminars.

Literature

We cover a range of themes related to development and neurobiology. Before starting your preparations, check with Jorge Pereira (jorge.pereira@biol.ethz.ch), who helps you with finding an appropriate paper.

Prerequisites / notice

You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

551-1105-00L Glycobiology

Glycobiology

W 4 credits 2V M. Aebi, T. Hafen

Abstract

From DNA to Diversity (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO336

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Objective

You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

Content

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

Lecture notes

Presentations will be made available after the seminars.

Literature

We cover a range of themes related to development and neurobiology. Before starting your preparations, check with Jorge Pereira (jorge.pereira@biol.ethz.ch), who helps you with finding an appropriate paper.

Prerequisites / notice

You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).
Prerequisites / notice

The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1145-00L  
Viral and Non-Viral Vectors for Human Gene-Therapy - from Pathogens to Safe Medical Applications  
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.  
UZH Module Code: BIO708

Abstract

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. 
http://www.uzh.ch/studies/application/mobilitaet_en.html

Objective


551-1153-00L  
Systematics of Metabolism  
Number of participants limited to 15.

Abstract

Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective

Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content

The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics.

Lectures

University lecturers

Literature

Original and review articles will be distributed during the course.

Prerequisites / notice

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

551-1171-00L  
Immunology: from Milestones to Current Topics  
Number of participants limited to 15.

Abstract

Milestones in Immunology: on old concepts and modern experiments

Objective

The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Content

Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunity.

Lecture notes

Script and original publications will be supplied during the course.

Prerequisites / notice

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

551-1303-00L  
Current Research Topics in Cellular Biochemistry  
Number of participants limited to 15.

Abstract

Introduction, presentation, evaluation, critical discussion and written analysis of recent scientific articles in the research area of cellular biochemistry.

Objective

The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

Content

The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

Literature

The relevant references to primary literature and review articles will be provided during the course.

Prerequisites / notice

The course will be taught in English.

551-1323-00L  
Fundamentals of Biology II: Biochemistry and Molecular Biology  

Abstract

The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

Objective

Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycan, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

Lecture notes

none

Literature


Prerequisites / notice

Some of the lectures are given in the English language.

636-0003-00L  
Biological Engineering and Biotechnology  

Abstract

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutically effective to market.

Notice

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Survey

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

Enrolment

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

Molecular Evolution, Phylogenetics and Phylo dynamics

Objective

The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Content

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or specialization & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clans.

Lecture notes

Slides of the lecture will be available online.

Literature

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics.

636-0017-00L

Molecular Evolution, Phylogenetics and Phylodynamics

W

4 credits

3G

T. Stadler

636-0507-00L

Synthetic Biology II

W

4 credits

4A

S. Panke, Y. Benenson, J. Stelling

Abstract

7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content

Presentations on advanced synthetic biology topics (e.g genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes

Handouts during course

Prerequisites / notice

The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

752-4009-00L

Molecular Biology of Foodborne Pathogens

W

3 credits

2V

M. Loessner, M. Schuppler

Abstract

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microbial organism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Content

Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes

Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature

Recommendations will be given in the first lecture

Prerequisites / notice

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

752-6101-00L

Nutrition and Chronic Disease (HS)

W

3 credits

2V

M. B. Zimmermann

Abstract

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective

To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

There is no script. Powerpoint presentations will be made available on-line to students.

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

### Major in Neurosciences

#### Compulsory Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-0300-00L</td>
<td>Translational Science for Health and Medicine</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>J. Goldhahn, C. Wolfrum</td>
</tr>
</tbody>
</table>

**Abstract**

Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

**Objective**

After completing this course, students will be able to understand:

- Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

**Content**

What is translational science and what is it not?
- How to identify need?
  - Disease concepts and consequences for research
  - Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
  - Outcome variables
  - Improving the translational process
  - Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

#### Electives

#### Elective Courses I

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>376-1305-00L</td>
<td>Development of the Nervous System</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>E. Stoeckli, further lecturers</td>
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</tbody>
</table>

**Abstract**

The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

**Objective**

The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.

**Content**

The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

**Lecture notes**

Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/ as BIO344

**Literature**

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

**Prerequisites / notice**

None. Bring something to write and your student ID

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>376-1305-01L</td>
<td>Structure, Plasticity and Repair of the Nervous System</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. E. Schwab, L. Fili, K. A. Martin, further lecturers</td>
</tr>
</tbody>
</table>

**Abstract**

The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

**Objective**

The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

**Content**

The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

**Lecture notes**

ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694

Password will be provided at the beginning of the lecture.

UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/

**Literature**

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

**Prerequisites / notice**

Repetitionsprüfung 15. Juni 2016, HG E 26.1, 9-10.30h
### Elective Courses II

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<tr>
<th>Number</th>
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<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Beck, P. Kourmoutsakos</td>
</tr>
</tbody>
</table>

**Abstract**
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

**Objective**
The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

**Content**
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

**Lecture notes**
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

**Literature**
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

**Prerequisites / notice**
Fundamentals of Probability, Fundamentals of Computational Modeling

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<tbody>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6 credits</td>
<td>3V+1U</td>
<td>G. Székely, O. Göksel, L. Van Gool</td>
</tr>
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</table>

**Abstract**

**Objective**
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

**Content**
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

**Lecture notes**
Course material Script, computer demonstrations, exercises and problem solutions

**Prerequisites / notice**
Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

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<tbody>
<tr>
<td>227-1035-00L</td>
<td>Dynamical Systems in Biology</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>R. Stoop</td>
</tr>
</tbody>
</table>

**Abstract**
This lecture uses the concepts from dynamical systems (Course: "Computable Chaos in Dynamical Systems") for the description of salient phenomena in complex examples from population dynamics, neuroinformatics and system biology. A particular focus is on the concept of limit cycle solutions and their coupling.

**Objective**
Applying concepts from nonlinear dynamics to biological systems. Combining theoretical modeling with supporting computer simulations.

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<tbody>
<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
</tr>
</tbody>
</table>

**Abstract**
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

**Objective**
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monochromes of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enclaves and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

**Content**
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerve synapses are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor integration in neural networks.

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</thead>
<tbody>
<tr>
<td>227-1045-00L</td>
<td>Readings in Neuroinformatics</td>
<td>W</td>
<td>3 credits</td>
<td>1S</td>
<td>G. Indiveri, M. Cook, D. Kiper</td>
</tr>
</tbody>
</table>

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. We will read both original papers and explore the conceptual links between them and discuss the ‘sociology’ of science, the pursuit of basic science questions over a century of research.*
Objective

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unlike the introductory survey, which only covers one area of research, we will explore these areas of research by reading the original publications, instead of reading someone else's digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and by many different scientists, linked together to generate the current view of mechanism and structure. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. Each week the course members will be given original papers to read for homework, they will have to write a short abstract for each paper. We will then meet weekly with the course leader (KACM) and an assistant for an hour or so long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will be in the form of a written exam in which the students will be given a paper and asked to write a short abstract of the contents.

Content

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unlike the introductory survey, which only covers one area of research, we will explore these areas of research by reading the original publications, instead of reading someone else's digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and by many different scientists, linked together to generate the current view of mechanism and structure. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. Each week the course members will be given original papers to read for homework, they will have to write a short abstract for each paper. We will then meet weekly with the course leader (KACM) and an assistant for an hour or so long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will be in the form of a written exam in which the students will be given a paper and asked to write a short abstract of the contents.
Different scientific guests working in the field of molecular cognition, neurochemistry, neuromorphology and neurophysiology present their latest scientific results.

The objective of this course is to give an introduction to the fundamentals of physical human-robot interaction, through lectures on the underlying theoretical/mechatronic aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neuropsychology, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits. Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://edu.haptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instability (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

Will be distributed through the document repository before the lectures.

http://www.relab.ahtz.ch/education/courses/phri.html


For students: Critical discussion of current research. Students aiming at getting a credit point for this colloquium choose one topic and write a critical essay on the presented research topic.

To exchange scientific knowledge and data and to promote communication and collaborations among researchers.
Prerequisites / notice

Notice:
The registration is limited to 26 students.
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/pHRI

551-0309-00L Concepts in Modern Genetics W 6 credits 4V Y. Barral, D. Bopp, A. Hajnal, O. Voinnet

Abstract
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective
This course focuses on the concepts of classical and modern genetics and genomics.

Content
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes
Scripts and additional material will be provided during the semester.

Prerequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel.

551-0317-00L Immunology I W 3 credits 2V A. Oxenius, M. Kopf

Abstract
Introduction into structural and functional aspects of the immune system.
Basic knowledge of the mechanisms and the regulation of an immune response.

Objective
Introduction into structural and functional aspects of the immune system.
Basic knowledge of the mechanisms and the regulation of an immune response.

Content
- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histoincompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Literature

Prerequisites / notice
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, C. M. Azzalin, B. Kornmann, M. Peter

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytokoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

551-1145-00L Viral and non-Viral Vectors for Human Gene-Therapy - W from Pathogens to Safe Medical Applications 2 credits 3V University lecturers

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO/708

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

Objective
Knowledge of important viral and non-viral vector systems.
Knowledge of application in human diseases.
Knowledge of limiting factors.

752-4009-00L Molecular Biology of Foodborne Pathogens W 3 credits 2V M. Loessner, M. Schuppeler

Abstract
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school).

ECTS Students should exercise scientific working and/or get realistic insights into future jobs.

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

752-6403-00L Nutrition and Performance W 2 credits 2V S. Mettler, M. B. Zimmermann
Objective: To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

752-6400-00L Nutrition and Performance W 2 credits 2V S. Mettler, M. B. Zimmermann
Objective: To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise.

Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

Practical Training and Semester Project

Practical Training and Semester Project only for majors below-mentioned:
- Human Movement Science and Sport
- Health Technologies
- Molecular Health Sciences
- Neurosciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-2110-00L</td>
<td>Internship 12 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>15 credits</td>
<td>34P</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school).</td>
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</tr>
<tr>
<td>Objective</td>
<td>Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>This version of internships lasts for at least 12 weeks full time equivalent.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-2111-00L</td>
<td>Internship 8 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>10 credits</td>
<td>23P</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school).</td>
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<tr>
<td>Objective</td>
<td>Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This version of internships lasts for at least 8 weeks full time equivalent.</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-2112-00L</td>
<td>Internship 4 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>5 credits</td>
<td>11P</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school).</td>
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<tr>
<td>Objective</td>
<td>Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This version of internships lasts for at least 4 weeks full time equivalent.</td>
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Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-HEST.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Research Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-2100-00L</td>
<td>Research Internship</td>
<td>O</td>
<td>15 credits</td>
<td>36A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>12-week internship intended for exercising (independent) scientific working.</td>
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<tr>
<td>Objective</td>
<td>Students shall exercise scientific working as preparation for their master thesis.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The Research Internship lasts for at least 12 weeks full time equivalent. It can be combined with the Master Thesis.</td>
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Master Thesis

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-2000-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>71D</td>
<td>Supervisors</td>
</tr>
<tr>
<td>Only students fulfilling the following criteria can start with their master thesis:</td>
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<tr>
<td>a. successful completion of the bachelor programme;</td>
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</table>
| b. fulfillment of any additional requirements necessary to
gain admission to the master programme.

Abstract
6-months research study with topics from the chosen major within the field of Health Sciences and Technology. In general, it includes the study of existing literature, the specification of the research question, the choice of the methodological approach, the collection, analysis and interpretation of data, and the written and oral reporting of the findings.

Objective
The students shall demonstrate their ability to carry out a structured, scientific piece of work independently.

Prerequisites / notice
The Master Thesis can only be started after the Bachelor Degree was obtained and/or master admission requirements have been fulfilled.

Course Units for Additional Admission Requirements

The courses below are only for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0253-AAL</td>
<td>Mathematics I &amp; II</td>
<td>E-</td>
<td>13</td>
<td>28R</td>
<td>A. Cannas da Silva</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional requirement.</td>
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<tr>
<td>Abstract</td>
<td>Mathematics I covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations. Main focus of Mathematics II: multivariable calculus and partial differential equations.</td>
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<tr>
<td>Objective</td>
<td>Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment. The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.</td>
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<tr>
<td>Content</td>
<td>1. Linear Algebra and Complex Numbers: systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.</td>
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<td>3. Ordinary Differential Equations: separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.</td>
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<td>4. Multivariable Differential Calculus: functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.</td>
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<td></td>
<td>5. Multivariable Integral Calculus: multiple integrals, line and surface integrals, work and flow, Green, Gauss and Stokes theorems, applications.</td>
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<tr>
<td>Literature</td>
<td>- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).</td>
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<tr>
<td>551-0110-AAL</td>
<td>Fundamentals of Biology II: Microbiology</td>
<td>E-</td>
<td>2</td>
<td>2R</td>
<td>J. Vorholt-Zambelli</td>
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<td></td>
<td>Enrolment only for MSc students who need this course as additional requirement.</td>
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<tr>
<td>Abstract</td>
<td>Structure, function, genetics of prokaryotic microorganisms and fungi.</td>
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<tr>
<td>Lecture notes</td>
<td>none</td>
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<tr>
<td>Literature</td>
<td>none</td>
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</table>

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

Main focus of Mathematics II: multivariable calculus and partial differential equations.

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

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional requirement.</td>
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<tr>
<td>551-0108-AAL</td>
<td>Fundamentals of Biology II: Plant Biology</td>
<td>E-</td>
<td>2</td>
<td>2R</td>
<td>W. Gruissem</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
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<tr>
<td>Objective</td>
<td>Water balance, assimilation, transport in plants; developmental biology, stress physiology.</td>
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<tr>
<td>Lecture notes</td>
<td>none</td>
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<td></td>
</tr>
<tr>
<td>Literature</td>
<td>none</td>
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</tbody>
</table>

Full credit is granted if the student is able to reach the objectives of the course and pass the examination. The master's thesis can only be started after the Bachelor Degree was obtained and master admission requirements have been fulfilled.

Health Sciences and Technology Master - Key for Type

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Core Courses in Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>G. Isidori</td>
</tr>
</tbody>
</table>

**Abstract**
This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity.

- Relativistic quantum mechanics
- Quantisation of bosonic and fermionic fields
- Interactions in perturbation theory
- Scattering processes and decays
- Radiative corrections

**Objective**
The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.

### Core Courses in Experimental Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0891-00L</td>
<td>Phenomenology of Particle Physics I</td>
<td>W</td>
<td>10</td>
<td>3V+2U</td>
<td>A. Gehrmann-De Ridder, C. Grab</td>
</tr>
</tbody>
</table>

**Abstract**
Topics to be covered both in Phenomenology of Particle Physics I and II:
- relativistic kinematics
- cross section and phase space
- elements of quantum electrodynamics
- perturbation theory
- unitary symmetries and QCD
- electro-weak interaction
- flavour physics
- neutrino physics

**Objective**
Introduction into modern particle physics

**Content**
Topics to be covered both in Phenomenology of Particle Physics I and II:
- relativistic kinematics
- cross section and phase space
- elements of quantum electrodynamics
- perturbation theory
- unitary symmetries and QCD
- electro-weak interaction
- flavour physics
- neutrino physics

**Literature**
I.J.R. Aitchison, A.J.G. Hey, "Gauge Theories in Particle Physics"
A. Seiden, "Particle Physics - A comprehensive introduction"
F. Halzen, A. Martin, "Quarks and Leptons"

### Electives

### Optional Subjects in Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0715-00L</td>
<td>Low Energy Particle Physics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>A. S. Antognini, F. Piegsa</td>
</tr>
</tbody>
</table>

**Abstract**
Low energy particle physics provides complementary information to high energy physics with colliders. In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today.

**Objective**
The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons.

**Content**
Low energy particle physics provides complementary information to high energy physics with colliders. At the Large Hadron Collider one directly searches for new particles at energies up to the TeV range. In a complementary way, low energy particle physics indirectly probes the existence of such particles and provides constraints for "new physics", making use of precision and high intensities.

Besides the sensitivity to effects related with new physics (e.g. lepton flavor violation, symmetry violations, CPT tests, search for electric dipole moments, new low mass exchange bosons etc.), low energy physics provides the best test of QED (electron g-2), the best tests of bound-state QED (atomic physics and exotic atoms), precise determinations of fundamental constants, information about the CKM matrix, precise information on the weak and strong force even in the non-perturbative regime etc.

In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Starting from a general introduction on high intensity/high precision particle physics and the main characteristics of muons and neutrons and their production, we will then focus on the discussion of fundamental problems and ground-breaking experiments:

- Production and characteristics of muon and neutron beams
- Ultracold neutron production
- Measurement of the neutron lifetime and electric dipole moment
- The neutron in the gravitational field and its electric charge
- Muon and neutron decay correlations
- Lepton flavour violations with muons to search for new physics
- What atomic physics can do for particle physics and vice versa
- Laser experiments at accelerators
- From myonic hydrogen to the proton structure and bound-state QED
- From pionic hydrogen to the strong interaction and effective field theories
- etc.

**Literature**
Golub, Richardson & Lamoreaux: "Ultra-Cold Neutrons"
Rauch & Werner: "Neutron Interferometry"
Carlile & Willis: "Experimental Neutron Scattering"
Byrne: "Neutrons, Nuclei and Matter"
Klapdor-Kleingrothaus: "Non Accelerator Particle Physics"
Experimental Methods and Instruments of Particle Physics

Objective
To gain familiarity with the formalism of lattice field theories and their numerical simulation methods.

Content
1. Examples of modern experiments
2. Basics: Bethe-Bloch, radiation length, nucl. interaction length, fixed-target vs. collider, principles of measurements: energy- and momentum-conservation, etc
3. Physics and layout of accelerators
4. Charged particle tracking and vertexing
5. Calorimetry
6. Particle identification
7. Analysis methods: invariant and missing mass, jet algorithms, b-tagging
8. Special detectors: extended airshowers, emulsions, cryogenic detectors for dark matter detection
9. MC simulations (GEANT), trigger, readout, electronics

Lecture notes
Slides are handed out regularly, see www.physik.uzh.ch/lectures/empp/

Astro-Particle Physics I

Objective
Acquire an in-depth understanding and overview of the essential elements of experimental methods in particle physics, including accelerators and experiments.

Content
1. First semester (Astro-Particle Physics I):
   - experimental methods to measure cosmic ray particles over full energy range
   - current knowledge about the composition of cosmic ray
   - possible cosmic acceleration mechanisms
   - correlation between astronomical object classes and cosmic accelerators
   - information about our galaxy and cosmology gained from observations of cosmic ray
2. Second semester:
   - 'anti-matter problem' and the Big Bang
   - 'knee' and 'ankle' in the energy spectrum
   - 'extended air showers' and 'cosmic muons'
   - solar neutrinos
   - uncertain neutrino oscillations, interactions with leptons and quarks
   - information about our galaxy and cosmology gained from observations of cosmic ray

Lecture notes
See lecture home page: http://ihp-lx2.ETHZ.ch/AstroTeilchen/

Introduction to Lattice QCD

Objective
Successful students know:
- the ‘anti-matter problem’ and the Big Bang
- the 'knee' and 'ankle' in the energy spectrum
- solar neutrinos
- uncertain neutrino oscillations, interactions with leptons and quarks
- information about our galaxy and cosmology gained from observations of cosmic ray

Content
- Theoretical basis and selected experiments to determine the properties of neutrinos and their interactions (mass, spin, helicity, chirality, oscillations, interactions with leptons and quarks).
- Introduction to the physics of neutrinos with special consideration of phenomena connected with neutrino masses.

Lecture notes
Script

Symmetries in Physics

Objective
The aim of the course is to give a self-contained introduction into finite group theory as well as Lie theory from a physicists point of view. Abstract mathematical constructions will be illustrated with examples from physics.

Content
- The course gives an introduction to symmetry groups in physics. It will explain the relevant mathematical background (finite groups, Lie groups and algebras as well as their representations), and illustrate their important role in modern physics.
- The theory of Lie groups and Lie algebras is applied to various examples, such as the classification of elementary particles and the Standard Model of particle physics.

Lecture notes

General Relativity

Objective
Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.
The Physics of Electroweak Symmetry Breaking

The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

**Objective**

The course aims to understand the need of physics beyond the Standard Model, the basic techniques of model building in theories BSM and the elements of collider physics required to analyze their phenomenological implications. After an introduction to the SM and alternative theories of electroweak symmetry breaking, we will investigate these issues in the context of models with warped extra dimensions.

**Prerequisites / notice**

The former title of this course unit was "The Physics Beyond the Standard Model!". If you already got credits for "The Physics Beyond the Standard Model" (402-0898-00L), you cannot get credits for "The Physics of Electroweak Symmetry Breaking" (402-0898-00L).

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**Suggested textbooks:**

- C. Misner, K. Thorne and J. Wheeler: Gravitation
- S. Carroll - Spacetime and Geometry: An Introduction to General Relativity
- R. Wald - General Relativity
- S. Weinberg - Gravitation and Cosmology
- N. Straumann - General Relativity with applications to Astrophysics

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**Literature**

- Beyond Standard Model
- pseudo-observables / EFT
- off-shell measurements
- differential measurements
- combine information from all channels
- main channels overview
- Higgs Hunter's Guide
- (by S.Dawson, J. Gunion, H. Haber and G. Kane)
- Prerequisites: Quantum Field Theory I, Phenomenology of Particle Physics I
- Literature

---

**402-0898-00L**

**The Physics of Electroweak Symmetry Breaking**

**W** 6 credits 2V+1U  not available

**Abstract**

The aim is to understand the need of physics beyond the Standard Model, the basic techniques of model building in theories BSM and the elements of collider physics required to analyze their phenomenological implications. After an introduction to the SM and alternative theories of electroweak symmetry breaking, we will investigate these issues in the context of models with warped extra dimensions.

**Objective**

After the course the student should have a good knowledge of some of the most relevant theories beyond the Standard Model and have the techniques to understand those theories that have not been surveyed in the course. He or she should be able to compute the constraints on any model of new physics, its successes explaining current experimental data and its main phenomenological implications at colliders.

**Prerequisites / notice**

The former title of this course unit was "The Physics Beyond the Standard Model!". If you already got credits for "The Physics Beyond the Standard Model" (402-0898-00L), you cannot get credits for "The Physics of Electroweak Symmetry Breaking" (402-0898-00L).

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**402-0899-65L**

**Higgs Physics**

**W** 6 credits 2V+1U  M. Donegà, M. Grazzini

**Abstract**

The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

**Objective**

With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

**Content**

**Experimental part:**

- Introductory material:
  - reminders of detectors/accelerators
  - reminders of statistics: likelihoods, hypothesis testing
  - reminders of multivariate techniques: Neural Networks, Decision Trees
- Main topics:
  - pre-history (pre-LEP)
  - LEP1: measurements at the Z-pole
  - LEP2: towards the limit mH<114 GeV
  - TeVatron searches
  - LHC:
    - main channels overview
    -- dissect on analysis
    -- combine information from all channels
    -- differential measurements
    -- off-shell measurements
  - Future:
    -- pseudo-observables / EFT
    -- Beyond Standard Model
- Higgs Hunter's Guide
(by S.Dawson, J. Gunion, H. Haber and G. Kane)

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**Prerequisites / notice**

Prerequisites: Quantum Field Theory I, Phenomenology of Particle Physics I

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**402-0777-00L**

**Particle Accelerator Physics and Modeling I**

**W** 6 credits 2V+1U  A. Adelmann

**Abstract**

This is the first of two courses, introducing particle accelerators from a theoretical point of view and covers state-of-the-art modeling techniques. It emphasizes the multidisciplinary aspect of the field, both in methodology (numerical and computational methods) and with regard to applications such as medical, industrial, material research and particle physics.

**Objective**

You understand the building blocks of particle accelerators. Modern analysis tools allows you to model state-of-the-art particle accelerators. In some of the exercises you will be confronted with next generation machines. We will develop a Python simulation tool (AccelLEGOrator) that reflects the theory from the lecture.

**Content**

Here is the rough plan of the topics, however the actual pace may vary relative to this plan.

- Particle Accelerators an Overview
- Relativity for Accelerator Physicists
- Building Blocks of Particle Accelerators
- Lie Algebraic Structure of Classical Mechanics and Applications to Particle Accelerators
- Symplectic Maps & Analysis of Maps
- Particle Tracking
- Linear & Circular Machines
- Cyclotrons
- Free Electron Lasers
- Collective effects in linear approximation
- Outlook on Particle Accelerator Physics and Modeling II

**Literature**


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**402-0898-00L**

**The Physics of Electroweak Symmetry Breaking**

**W** 6 credits 2V+1U  not available

**Abstract**

The aim is to understand the need of physics beyond the Standard Model, the basic techniques of model building in theories BSM and the elements of collider physics required to analyze their phenomenological implications. After an introduction to the SM and alternative theories of electroweak symmetry breaking, we will investigate these issues in the context of models with warped extra dimensions.

**Objective**

After the course the student should have a good knowledge of some of the most relevant theories beyond the Standard Model and have the techniques to understand those theories that have not been surveyed in the course. He or she should be able to compute the constraints on any model of new physics, its successes explaining current experimental data and its main phenomenological implications at colliders.

**Prerequisites / notice**

The former title of this course unit was "The Physics Beyond the Standard Model!". If you already got credits for "The Physics Beyond the Standard Model" (402-0898-00L), you cannot get credits for "The Physics of Electroweak Symmetry Breaking" (402-0898-00L).

---

**Suggested textbooks:**

- C. Misner, K. Thorne and J. Wheeler: Gravitation
- S. Carroll - Spacetime and Geometry: An Introduction to General Relativity
- R. Wald - General Relativity
- S. Weinberg - Gravitation and Cosmology
- N. Straumann - General Relativity with applications to Astrophysics
Prerequisites / notice

This lecture is also suited for PhD. students.

402-0851-00L QCD: Theory and Experiment

Abstract
An introduction to the theoretical aspects and experimental tests of QCD, with emphasis on perturbative QCD and related experiments at colliders.

Objective
Knowledge acquired on basics of perturbative QCD, both of theoretical and experimental nature. Ability to perform simple calculations of perturbative QCD, as well as to understand modern publications on theoretical and experimental aspects of perturbative QCD.

Content
QCD Lagrangian and Feynman Rules
QCD running coupling
Parton model
Altarelli-Parisi equations
Basic processes
Experimental tests at lepton and hadron colliders
Measurements of the strong coupling constant

Literature
2) R. K. Ellis, W. J. Stirling, B. R. Webber: "QCD and Collider Physics" (Cambridge Monographs on Particle Physics, Nuclear Physics & Cosmology)

Prerequisites / notice
Will be given as block course, language: English.
For students of both ETH and University of Zurich.

Optional Subjects in Mathematics

Number Title Type ECTS Hours Lecturers
401-3531-00L Differential Geometry I W 10 credits 4V+1U M. Burger

Abstract
This course is an introduction to differential and riemannian geometry.

Objective
The aim is to lead students from a reasonable knowledge of advanced calculus, basic knowledge of general topology and solid knowledge of linear algebra to fundamental knowledge of differentiable manifolds and their basic tools. Riemannian geometry, some basic Lie theory, and de Rham cohomology will be developed as applications.

Literature
W. Boothby: "An introduction to differentiable manifolds and Riemannian Geometry"
J.M. Lee: "Introduction to smooth manifolds"
M.P. Do Carmo: "Riemannian Geometry"

401-3461-00L Functional Analysis I

Abstract
Baire category; Banach and Hilbert spaces, bounded linear operators; Three Fundamental Principles: Uniform Boundedness, Open Mapping/Closed Graph, Hahn-Banach; Convexity; Dual Spaces: weak and weak* topologies, Banach-Alaoglu, reflexive spaces; Ergodic Theorem; compact operators and Fredholm theory; Closed Image Theorem; Spectral theory, self-adjoint operators.

Prerequisites / notice
Lecture Notes on "Functional Analysis" by D.A. Salamon.

Proseminars and Semester Papers

Number Title Type ECTS Hours Lecturers
402-0717-MSL Particle Physics at CERN

Abstract
During the semester break participating students stay for 4 weeks at CERN and perform experimental work relevant to our particle physics projects. Dates to be agreed upon.

Objective
Students learn, by doing, the needed skills to perform a small particle physics experiment: setup, problem solving, data taking, analysis, interpretation and presentation in a written report of publication quality.

Content
Detailed information in: http://www/cmsdoc.cern.ch/~nessif/ETHTeilchenpraktikumCERN.html

Prerequisites / notice
Language of instruction: English or German.

402-0719-MSL Particle Physics at PSI (Paul Scherrer Institute)

Abstract
During semester breaks 6-12 students stay for 3 weeks at PSI and participate in a hands-on course on experimental particle physics. A small real experiment is performed in common, including apparatus design, construction, running and data analysis. The course includes some lectures, but the focus lies on the practical aspects of experimenting.

Objective
Students learn all the different steps it takes to perform a complete particle physics experiment in a small team. They acquire skills to do this themselves in the team, including design, construction, data taking and data analysis.

402-0210-9SL Proseminar Theoretical Physics: Particle Physics at the Energy Frontier Number of participants limited to 24.

Abstract
A guided self-study of original papers and of advanced textbooks in theoretical physics. Within the general topic, determined each semester, participants give a presentation on a particular subject and deliver a written report.

402-0217-MSL Theoretical Semester Project in a Group of the Physics Department

Abstract
This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available if the proseminar is already overbooked.

Prerequisites / notice
Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein.

402-0215-MSL Experimental Semester Project in a Group of the Physics Department

Abstract
The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.

Prerequisites / notice

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type)

### Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>402-2000-00L</td>
<td>Scientific Works in Physics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>D. Würtz</td>
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</tbody>
</table>

**Target audience:**
- Master students who cannot document to have received an adequate training in working scientifically.
- Mandatory for all Master students with matriculation in the autumn semester 2014 or later.
- Optional for Master students with matriculation until or before the spring semester 2014.

**Directive**

**Abstract**
- Literature Review: ETH-Library, Journals in Physics, Google Scholar
- Thesis Structure: The IMRAD Model
- Document Processing: LaTeX and BibTeX
- Mathematical Writing
- AVETH Survival Guide
- ETH Guidelines for Integrity
- Authorship Guidelines
- ETH Citation Etiquettes
- Declaration of Originality

**Objective**
- Basic standards for scientific works in physics: How to write a Master Thesis. What to know about research integrity.

| 462-0900-00L | Master's Thesis | O    | 30   | 57D   | Supervisors |

**Abstract**
- The Master's thesis is normally conducted in the fourth semester and concludes the degree programme. With the Master's thesis students verify their ability to undertake independent and scientifically structured work in the area of high energy physics.

**Prerequisites / notice**
- The time limit for completing the Master's thesis is six months.

### High-Energy Physics (Joint Master with EP Paris) - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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<tbody>
<tr>
<td>W+</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

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<th>V</th>
<th>lecture</th>
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<th>practical/laboratory course</th>
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<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

**ECTS**
- European Credit Transfer and Accumulation System

**Special students and auditors need special permission from the lecturers.**
Information Systems for Engineers

Foundations of information systems from a user's viewpoint. The focus is on structured data: relational databases, the data language SQL, expressing and querying data, as well as an introduction to object-oriented programming. Additional topics: Information Retrieval (searching documents), and estimating their relevance and authority with respect to free-text queries; XML as a format for data exchange; Characteristics and processing of "Big Data".

Following the course should enable students to

1. answer non-trivial queries on existing relational databases by formulating (entry-level) SQL statements, as well as to add new database content and to update or delete existing content,
2. formalize facts as perceived in the real world in terms of the entity-relationship model, and derive a set of normalized relations (tables) which define the structure of a relational database
3. explain how a database management system (DBMS) essentially works and what kind of services it provides
4. understand how a web search engine such as Google basically works
5. know and apply the core concepts to structure and query XML-documents
6. list the characteristics of "Big Data" and know the basics of processing "Big Data"

Im Zentrum stehen relationale Datenbanksysteme, die Abfrage- und Datenmanipulationssprache SQL sowie der Entwurf bzw. die Strukturierung relationaler Datenbanken. Dieser Stoff wird auch in praktischen Übungen vertieft.

Weitere Themen sind der Umgang mit unstrukturierten und semistrukturierten Daten, die Integration von Daten aus verschiedenen autonomen Informationssystemen, sowie eine Übersicht der Architektur von Datenbanksystemen.

Vorlesungsunterlagen (PowerPoint Folien, teilweise auch zusätzlicher Text) werden auf der Web-Site publiziert. Der Kauf eines Buches wird nicht vorausgesetzt.


Prerequisites / notice

Voraussetzung:

Computer Science I

The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Teached language is C++. No programming experience is required.

Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the secenes" when a program is translated and executed.

Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.

The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphy, simple dynamic data types are introduced as examples, in general the concepts provided in the course are motivated and illustrated with algorithms and applications.

A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page.

Examination is a one hour long written test.

Informatics

A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page.

Examination is a one hour-long written test.
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: publishing over the internet, processing and visualizing time series, visualizing multi-dimensional data, managing data with lists and tables, and relational databases, introduction to macro programming, universal methods for algorithm design.

The students learn to:

- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

1. Simulation and Modeling
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

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

This course is based on application-oriented learning. The students spend most of their time working through electronic tutorials and discussing their results with teaching assistants.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.
The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.

The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

The course covers the didactics of logic, of cryptography, of finite state automata, of computability and of the introduction to programming. The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

Lecture notes

Literature


252-0860-00L

Abstract

Discrete Mathematics

Foundations of Discrete Mathematics; combinatorics (elementary counting), graph theory (paths, walks, euler circuits, matchings, trees, planar graphs), algebra (modular arithmetic, groups, fields), applications (network flows, cryptography, coding theory).

Objective

see above

Course: Computer Science Colloquium

Type E-

ECTS 0 credits

Hours 2K

Lecturers

J. Hromkovic, H. Klemenz

Number

Title

E- 0 credits

Lecturers

251-0100-00L

Computer Science Colloquium

Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.

Objective

Top international computer scientists take the floor at the distinguished computer science colloquium. Our guest speakers present impacting topics across various areas of the discipline. The colloquium series is held every semester and also includes inaugural and farewell lectures of the department's professors. The colloquium is a noteworthy event for all graduate students. Outside attendance is equally welcome.

Content

Eingeladene Vorträge aus dem gesamten Bereich der Informatik, zu denen auch Auswärtige kostenlos eingeladen sind. Zu Semesterbeginn erscheint jeweils ein ausführliches Programm.

401-5960-00L

Colloquium on Mathematics, Computer Science, and Education

Subject didactics for mathematics and computer science teachers.

Objective

Didactics colloquium

Number

Title

E-

0 credits

N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz

Computer Science (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>O</th>
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<tr>
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<tr>
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### Key for Hours

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<td>diploma thesis</td>
</tr>
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<td>R</td>
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</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Computer Science Bachelor

1. Semester

First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0211-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>M. Struwe</td>
</tr>
<tr>
<td></td>
<td>4V+2U</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
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<tr>
<td>401-0131-00L</td>
<td>Linear Algebra</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>M. Pollefeys, A. Steiger</td>
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<td></td>
<td>4V+2U</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
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2. Semester

Compulsory Courses (3. Sem.)

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0131-00L</td>
<td>Linear Algebra</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>M. Pollefeys, A. Steiger</td>
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<tr>
<td></td>
<td>4V+2U</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
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</table>

This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:
- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

Lecture notes
The lecture is covered in detail by the textbook "Theoretical Computer Science".

Basic literature:

Further reading:

More exercises and examples in:
6. A. Asteroth, Ch. Baier: Theoretische Informatik

Prerequisites / notice
During the semester, two non-obligatory test exams will be offered.
Objective
a) ability to understand the covered methods from probability theory and to apply them in other contexts
b) probabilistic thinking and stochastic modelling
c) ability to perform basic statistical tests and to interpret the results

Content
Basic concepts from probability and statistics with special emphasis on the topics needed in computer science

The conceptual goals are
- the laws of randomness and probabilistic thinking (thinking in probabilities)
- understanding and intuition for stochastic modelling
- simple and basic methods from statistics

The contents of the course encompasses
- an introduction to probability theory: basic concepts (probability space, probability measure), independence, random variables, discrete and continuous distributions, conditional probability, expectation and variance, limit theorems
- methods from statistics: parameter estimation, maximum likelihood and moment methods, tests, confidence intervals

Lecture notes
Lecture notes for the course (in German) will be made available electronically at the beginning of the course.

401-0663-00L Numerical Methods for CSE

Objective
- Knowledge of the fundamental algorithms in numerical mathematics
- Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
- Ability to choose the appropriate numerical method for concrete problems
- Ability to interpret numerical results
- Ability to implement numerical algorithms efficiently

Content
1. Direct Methods for linear systems of equations
2. Interpolation
3. Iterative Methods for non-linear systems of equations
4. Krylov methods for linear systems of equations
5. Eigensolvers
6. Least Squares Techniques
7. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Clustering Techniques
11. Single Step Methods for ODEs
12. Stiff Integrators
13. Structure Preserving Integrators

Lecture notes
Lecture slides will be made available to participants.

Literature
M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002
C. Moler, Numerical computing with MATLAB, SIAM, 2004
P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice
The course will be accompanied by programming exercises relying on the high level programming language MATLAB. A brief introduction to Matlab will be given during the first week.

Compensatory Courses
Compulsory major courses count as compensatory courses.

Major
Compulsory Major Courses
Major in Computer and Software Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0210-00L</td>
<td>Compiler Design</td>
<td>O</td>
<td>8</td>
<td>4V+3U</td>
<td>T. Gross</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufmann Publishers, 1997</td>
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</tbody>
</table>

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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0213-00L</td>
<td>Distributed Systems</td>
<td>O</td>
<td>8</td>
<td>6G+1A</td>
<td>F. Mattern, R. Wattenhofer</td>
</tr>
<tr>
<td>Abstract</td>
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<tr>
<td>Literature</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prior exposure to modern techniques for program construction, knowledge of at least one processor architecture at the assembly language level.</td>
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</tbody>
</table>
This course is an opportunity to take part in leading-edge software construction and gain academic credit for it. The EiffelStudio environment provides a rich basis of extensions and new developments. The course will be held in laboratory-style: students choose a project and meet regularly with assistants. The best developments are candidate for inclusion in actual software releases.

### Major in Computational Science

The lecture 151-0107-20L High Performance Computing for Science and Engineering I in the autumn semester can only together with the lecture 401-0686-10L High Performance Computing for Science and Engineering II in the spring semester be accredited as compulsory course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0206-00L</td>
<td>Visual Computing</td>
<td>O</td>
<td>8 credits</td>
<td>4V+3U</td>
<td>M. Gross, M. Pollefeys</td>
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<tr>
<td></td>
<td>This course acquaints students with core knowledge in computer graphics, image processing, multimedia and computer vision. Topics include: Graphics pipeline, perception and camera models, transformation, shading, global illumination, texturing, sampling, filtering, image representations, image and video compression, edge detection and optical flow.</td>
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<td></td>
<td>Objective This course provides an in-depth introduction to the core concepts of computer graphics, image processing, multimedia and computer vision.</td>
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<td>Content Course topics will include: Graphics pipeline, perception and color models, camera models, transformations and projection, projections, lighting, shading, global illumination, texturing, sampling theorem, Fourier transforms, image representations, convolution, linear filtering, diffusion, nonlinear filtering, edge detection, optical flow, image and video compression.</td>
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<td></td>
<td>Lecture notes In theoretical and practical homework assignments students will learn to apply and implement the presented concepts and algorithms.</td>
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<tr>
<td></td>
<td>Abstract This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.</td>
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<td></td>
<td>Objective Introduction to HPC for scientists and engineers Fundamental of:</td>
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<tr>
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<td>1. Parallel Computing Architectures</td>
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<td>2. MultiCores</td>
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<td>3. ManyCores</td>
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<td></td>
<td>Content Programming models and languages:</td>
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<tr>
<td></td>
<td>1. C++ threading (2 weeks)</td>
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<td>2. OpenMP (4 weeks)</td>
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<td>3. MPI (5 weeks)</td>
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<td>Computers and methods:</td>
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<tr>
<td></td>
<td>1. Hardware and architectures</td>
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<td>2. Libraries</td>
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<td></td>
<td>3. Particles: N-body solvers</td>
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<td></td>
<td>4. Fields: PDEs</td>
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<td>5. Stochastics: Monte Carlo</td>
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<td></td>
<td>Lecture notes A scriptum will be handed out for a part of the course. Copies of the slides will be available for download. We will also provide a detailed list of references and textbooks.</td>
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<td></td>
<td>Literature <a href="http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpces1">http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpces1</a></td>
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### Major in Theoretical Computer Science

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0209-00L</td>
<td>Algorithms, Probability, and Computing</td>
<td>O</td>
<td>8 credits</td>
<td>4V+2U+1A</td>
<td>E. Welzl, T. Holenstein, A. Steger</td>
</tr>
<tr>
<td></td>
<td>Abstract Advanced design and analysis methods for algorithms and data structures: Randomized(ized) Search Trees, Point Location, Minimum Cut, Linear Programming, Randomized Algebraic Algorithms (matchings), Probabilistically Checkable Proofs (introduction).</td>
<td></td>
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<tr>
<td></td>
<td>Objective Studying and understanding of fundamental advanced concepts in algorithms, data structures and complexity theory.</td>
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<tr>
<td></td>
<td>Lecture notes Will be handed out.</td>
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</table>

### Electives

Compulsory major courses may also qualify as electives. Students may also choose courses from the Master's program in Computer Science. It is their responsibility to make sure that they meet the requirements and conditions for these courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td></td>
<td>Abstract This course is an opportunity to take part in leading-edge software construction and gain academic credit for it. The EiffelStudio environment provides a rich basis of extensions and new developments. The course will be held in laboratory-style: students choose a project and meet regularly with assistants. The best developments are candidate for inclusion in actual software releases.</td>
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<td>Objective This course is an opportunity to take part in leading-edge software construction and gain academic credit for it. The EiffelStudio environment provides a rich basis of extensions and new developments. The course will be held in laboratory-style: students choose a project and meet regularly with assistants. The best developments are candidate for inclusion in actual software releases.</td>
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</table>

The growing popularity of open-source projects provides a fertile ground for creative software developers to demonstrate and hone their design and implementation skills. This course is an opportunity to take part in leading-edge software construction and gain academic credit for it. The EiffelStudio environment (in 2006, 2 million lines of open-source code) provides a rich basis of potential extensions and new developments. The course is not structured as a traditional set of lectures but is laboratory-style: students choose a project and meet regularly with assistants to report progress and obtain guidance. The results produced should meet standards of quality software engineering; the best developments are candidate for inclusion in actual software releases. This is an opportunity to learn by doing and to encounter the challenges of large, production-grade software development.

252-3110-00L Human Computer Interaction

Abstract

The course provides an introduction to the field of human-computer interaction, emphasising the central role of the user in system design. Through detailed case studies, students will be introduced to different methods used to analyse the user experience and shown how these can inform the design of new interfaces, systems and technologies.

Objective

The goal of the course is that students should understand the principles of user-centred design and be able to apply these in practice.

Content

The course will introduce students to various methods of analysing the user experience, showing how these can be used at different stages of system development from requirements analysis through to usability testing. Students will get experience of designing and carrying out user studies as well as analysing results. The course will also cover the basic principles of interaction design. Practical exercises related to touch and gesture-based interaction will be used to reinforce the concepts introduced in the lecture. To get students to further think beyond traditional system design, we will discuss issues related to ambient information and awareness.

252-4101-00L

Abstract

Solve programming problems from previous ACM Programming Contests (see http://acm.uva.es/problemset/); learn and use efficient programming methods and algorithms.

Objective

The objective of this course is to learn how to solve algorithmic problems given as descriptions in natural language, similar to those posed in ACM Programming Contests. This includes appropriate problem modeling, choice of suitable (combinatorial) algorithms, and their efficient implementation using C/C++ and the STL.

151-0107-20L High Performance Computing for Science and Engineering (HPCSE I)

Abstract

This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications in problems in science and engineering.

Objective

Introduction to HPC for scientists and engineers

Fundamental of:

1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content

Programming models and languages:

1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:

1. Hardware and architectures
2. Libraries
3. Particles; N-body solvers
4. Fields; PDEs
5. Stochastics; Monte Carlo

Lecture notes

http://www.cs-e-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcese1

Class notes, handouts

227-0627-00L Applied Computer Architecture

Abstract

This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.

Objective

Understand the function, design and the performance modeling of parallel computer systems.

Content

The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits.

Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?

Which architecture is behind the alarm center of the Swiss Railway (SBB)?

Which computer architectures are applied for driver assistance systems?

Which computer architecture is hidden behind a professional digital audio mixing desk?

How can data volumes about 30 TB/s, produced by a proton accelerator, be processed in real time?

Can the weather forecast also be processed with GPUs?

How can a good computer architecture be found?

Which are the driving factors in successful computer architecture design?

Lecture notes

Script and exercises sheets.

Prerequisites / notice

Prerequisites:

Basics of computer architecture.

227-0945-00L Cell and Molecular Biology for Engineers I

This course is part I of a two-semester course.

Abstract

The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in this field.

Objective

After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content

Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.

Lecture notes

Scripts of all lectures will be available.

Literature


227-1037-00L Introduction to Neuroinformatics

This course is part II of a two-semester course.

Abstract

The course gives an introduction into the field of neuroinformatics, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in this field.

Objective

After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content

Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.

Lecture notes

Scripts of all lectures will be available.

Literature

Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

Seminar

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-2600-05L</td>
<td>Software Engineering Seminar</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>T. Gross</td>
</tr>
</tbody>
</table>

Abstract
The course is an introduction to research in software engineering, based on reading and presenting high quality research papers in the field. The instructor may choose a variety of topics or one topic that is explored through several papers.

Objective
The main goals of this seminar are 1) learning how to read and understand a recent research paper in computer science; and 2) learning how to present a technical topic in computer science to an audience of peers.

Content
The focus of the course this year is on reliability of high-performance programs.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-INFK:

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0500-00L</td>
<td>Bachelor’s Thesis</td>
<td>O</td>
<td>10</td>
<td>21D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
The Bachelor thesis is the final requirement of the BSc program and is supervised by one of the D-INFK professors. The thesis encourages students to show and produce a scientifically structured work.

Objective
In their BSc thesis students should demonstrate their ability to carry out independent, structured scientific work.

Prerequisites / notice
The supervisor of the thesis defines the task, start and end date. A written report will be prepared on the scientific studies carried out, followed by a final presentation. The thesis must be handed in within 6 months.

Computer Science Bachelor - Key for Type

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

Key for Hours

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

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Computer Science TC

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
</tbody>
</table>

Number of participants limited to 30.

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

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

Objective
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

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

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
</tbody>
</table>

Number of participants limited to 30.

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

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

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

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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>

Number of participants limited to 30.

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

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

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

see Educational Science TC

Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>272-0101-00L</td>
<td>Subject Didactics of Computer Science I</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>G. Serafini, J. Hromkovic</td>
</tr>
</tbody>
</table>

Abstract
The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

Objective
The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.
The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

The chosen literature


**H.-J. Böckenhauer, J. Hromkovic:** Formale Sprachen: Endliche Automaten, Grammatiken, lexikalische und syntaktische Analyse. Springer Vieweg; Auflage: 1 (Januar 2013).

**J. Hromkovic:** Einführung in die Programmierung mit LOGO: Lehrbuch für Unterricht und Selbststudium. Springer Vieweg; Auflage: 3 (2014).


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<tr>
<td>272-0400-00L</td>
<td>Mentored Work Specialised Courses in the Respective W+ Subject with Educational Focus Computer Sc A</td>
<td>G</td>
<td>2</td>
<td>4A</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The aim is for the students - to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way. - to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readers. - To try out different options for specialist further training in their profession.</td>
<td></td>
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</tr>
</tbody>
</table>
| Content         | Thematicische Schwerpunkte:  
| Literature      | Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt. |
| Prerequisites   | Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden. |

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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 272-0401-00L    | Mentored Work Specialised Courses in the Respective W+ Subject with Educational Focus Computer Sc B  
- Dimension reduction: principal component analysis (PCA) and beyond  
- Non parametric density estimation: Parzen windows, nearest neighbour |
| Abstract        | In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level. |
| Objective       | The aim is for the students - to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way. - to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readers. - To try out different options for specialist further training in their profession. |
| Content         | Thematicische Schwerpunkte:  
| Literature      | Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt. |
| Prerequisites   | Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden. |

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</table>
| 263-2800-00L    | Design of Parallel and High-Performance Computing  
Topics covered in the lecture include:  
- Bayesian theory of optimal decisions  
- Maximum likelihood and Bayesian parameter inference  
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)  
- Ensemble methods: Bagging and Boosting  
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off  
- Non parametric density estimation: Parzen windows, nearest neighbour  
- Dimension reduction: principal component analysis (PCA) and beyond  
Lecture notes: No lecture notes, but slides will be made available on the course webpage. |
| Abstract        | Advanced topics in parallel / concurrent programming. |
| Objective       | Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore. |

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</tr>
</thead>
</table>
| 252-0341-01L    | Information Retrieval  
Topics covered in the lecture include:  
- Bayesian theory of optimal decisions  
- Maximum likelihood and Bayesian parameter inference  
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)  
- Ensemble methods: Bagging and Boosting  
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off  
- Non parametric density estimation: Parzen windows, nearest neighbour  
- Dimension reduction: principal component analysis (PCA) and beyond  
Lecture notes: No lecture notes, but slides will be made available on the course webpage. |
| Abstract        | Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation. |
| Objective       | In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods. |

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</tr>
</thead>
</table>
| 252-0535-00L    | Machine Learning  
Topics covered in the lecture include:  
- Bayesian theory of optimal decisions  
- Maximum likelihood and Bayesian parameter inference  
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)  
- Ensemble methods: Bagging and Boosting  
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off  
- Non parametric density estimation: Parzen windows, nearest neighbour  
- Dimension reduction: principal component analysis (PCA) and beyond  
Lecture notes: No lecture notes, but slides will be made available on the course webpage. |
| Abstract        | Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects. |
| Objective       | Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data. |
| Content         | The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data. |
### 252-1407-00L

#### Title:
Algorithmic Game Theory

#### Credits:
7 credits

#### Content:
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don’t care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

#### Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks

#### Literature
- "Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004
- Several copies of both books are available in the Computer Science library.

#### Prerequisites / notice
- Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.
- Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

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### 252-0417-00L

#### Title:
Randomized Algorithms and Probabilistic Methods

#### Credits:
7 credits

#### Content:
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

#### Outline:
- Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks
- After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

#### Literature

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### Computer Science TC - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>E</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

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### ECTS

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.

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Data: 06.12.2018 13:04

Autumn Semester 2015

Page 748 of 1432
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting.

Literature from the learning sciences is critically discussed with a focus on research methods.

The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning and Instruction. Cognitively Activating Instructions in MINT Subjects

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

For a rich and lively Semesterplanung wird um frühe Anmeldung und persönlichen Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

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

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

Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.

- Participants can design and conduct a study that is relevant for answering their research question.
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.

Learning goals include:

- Knowledge and skills are practiced during plenary meetings and in students' independent reading (e.g. generating and testing research hypotheses on their own). In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

The successful completion of both course no. 851-0240-00L "Menschliches Lernen (EW 1)" and course no. 851-0238-01L "Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)" is a necessary prerequisite for this course.

In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning and Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)

Learning goals include:

- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.
- Participants can design and conduct a study that is relevant for answering their research question.
- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.

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

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

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

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- Understanding research methods used in the empirical human sciences
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- Understanding and critically examine information from scientific journals and media
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Subject Didactics in Computer Science

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<td>O</td>
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<td>3G</td>
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**Abstract**
The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

**Objective**
The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

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**Content**
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The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

**Lecture notes**
Unterlagen und Folien werden zur Verfügung gestellt.

**Literature**


**Prerequisites / notice**
Lehrdiplom-Studierende müssen diese Lerneinheit zusammen mit dem Einführungspraktikum Informatik - 272-0201-00L - belegen.

<table>
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<td>272-0103-00L</td>
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<td>2</td>
<td>4A</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td></td>
<td>Mentored Work Subject Didactics in Computer Science for Tc, Teaching Diploma and Teaching Diploma Computer Science as Minor Subject</td>
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</tbody>
</table>

**Abstract**
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**
Themenatische Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

**Literature**
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

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

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>272-0104-00L</td>
<td>Mentored Work Subject Didactics Computer Science</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td></td>
<td>Mentored Work Subject Didactics in Computer Science for</td>
<td></td>
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</tbody>
</table>
Teaching Diploma and for students upgrading TC to Teaching Diploma.

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Thematic Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Literatur
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

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

Professional Training

<table>
<thead>
<tr>
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<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>272-0201-00L</td>
<td>Introductory Practical in Computer Science ■ Simultaneous enrolment in Subject Didactics of Computer Science I ■ course 272-0101-00L - is compulsory</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Abstract
During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

Objective
Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with their teaching practice. It forms a basis for the subsequent pedagogical and subject-didactics training.

Content

Literature
Wird von der Praktikumslehrperson bestimmt.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>272-0202-00L</td>
<td>Professional Exercises ■ In the course Professional Exercises the students achieve additional school-relevant experiences. The students carry out individually specified, practice related projects, in which they support, document or reflect on learning processes</td>
<td>O</td>
<td>2 credits</td>
<td>4U</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Abstract
In the course Professional Exercises the students achieve additional school-relevant experiences. The students carry out individually specified, practice related projects, in which they support, document or reflect on learning processes.

Objective
Achievement of additional school-relevant experiences. The students carry out individually specified, practice related projects, in which they support, document or reflect on learning processes.

Content
The course Professional Exercises offers the opportunity for additional school-relevant activities. The students are supported by the lecturers or by experienced teachers. They assist teachers at school, they create training systems and tests, correct the written homework of pupils and evaluate the progress of a class. The students create explanations and detailed solutions to exercises with respect to the actual knowledge of the pupils. A written assignment states the exact scope of the activity.

Literature
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

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</thead>
<tbody>
<tr>
<td>272-0203-00L</td>
<td>Teaching Internship in Computer Science ■ Teaching Internship Computer Science Teaching Diploma Computer Science as Major Subject</td>
<td>O</td>
<td>8 credits</td>
<td>17P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Abstract
The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialty to the educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

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

Content

Literature
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<tbody>
<tr>
<td>272-0204-00L</td>
<td>Teaching Internship in Computer Science ■ Teaching Internship for students upgrading TC to Teaching Diploma</td>
<td>W</td>
<td>4 credits</td>
<td>9P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Abstract
This is a supplement to the Teaching Internship required to obtain a Teaching Diploma in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.
Die Studierenden können die Bildung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbare (Fach-) Wissen zu erwerben.


**Examination Lesson I in Computer Science**

**Simultaneous enrolment in "Examination Lesson II in Computer Science" (272-0205-02L) is compulsory.**

**In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.**

**Objective**

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

**Content**


**Lecture notes**

Dokument: Schriftliche Vorbereitung für Prüfungsaufgaben.

**Prerequisites / notice**

Nach Abschluss der übrigen Ausbildung.


Teaching Diploma in 2 Subjects in One-Step Procedure: no courses from this category have to be completed.

<table>
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<tr>
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<tbody>
<tr>
<td>272-0400-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with Educational Focus Computer Sc A</td>
<td>2 credits</td>
<td>4A</td>
<td></td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.</td>
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<tr>
<td>Objective</td>
<td>The aim is for the students - to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way. - to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readers. - To try out different options for specialist further training in their profession.</td>
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<td>Literature</td>
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<td>Prerequisites / notice</td>
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**Data: 06.12.2018 13:04  Autumn Semester 2015  Page 752 of 1432**
Objective

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

Content

Thematiche Schwerpunkte:

Lernformen:

Literature

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

Prerequisites / notice

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

252-0341-01L

Information Retrieval

W 4 credits 2V+1U T. Hofmann

Abstract

Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.

Objective

In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge of basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.

252-0417-00L

Randomized Algorithms and Probabilistic Methods

W 7 credits 3V+2U+1A A. Steger

Abstract

Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

Objective

After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content

Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes

Yes


252-0535-00L

Machine Learning

W 6 credits 3V+2U J. M. Buhmann

Abstract

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes

No lecture notes, but slides will be made available on the course webpage.

Literature


Prerequisites / notice

Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

252-1407-00L

Algorithmic Game Theory

W 7 credits 3V+2U+1A P. Widmayer

Abstract

Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.

Objective

Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.
Content

The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don’t care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the “price of anarchy”.
- Auction-like mechanisms and algorithms that “direct” the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks

Lecture notes

No lecture notes.

Literature


"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Prerequisites / notice

Several copies of both books are available in the Computer Science library.

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

263-2800-00L Design of Parallel and High-Performance Computing W 7 credits 3V+2U+1A T. Hoefler, M. Püschel

Abstract

Advanced topics in parallel / concurrent programming.

Objective

Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

Compulsory Elective Courses

Further course offerings from the category Educational Science are listed under “Programme: Educational Science for Teaching Diploma and TC”.

see Compulsory Elective Courses Teaching Diploma

Additional Requirements (ETH-Masterstudents in PHYS/MATH/CSE)

Part 1

Number Title Type ECTS Hours Lecturers

252-0057-00L Theoretical Computer Science O 8 credits 4V+2U+1A J. Hromkovic, E. Welzl

Abstract

Concepts to cope with: a) what can be accomplished in a fully automated fashion (algorithmically solvable) b) How to measure the inherent difficulty of tasks (problems) c) What is randomness and how can it be useful? d) What is nondeterminism and what role does it play in CS? e) How to represent infinite objects by finite automata and grammars?

Objective

Learning the basic concepts of computer science along their historical development

Content

This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:
- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

Lecture notes

The lecture is covered in detail by the textbook “Theoretical Computer Science”.

Literature

Basic literature:

Further reading:

More exercises and examples in:
6. A. Asteroth, Ch. Baier: Theoretische Informatik

Prerequisites / notice

During the semester, two non-obligatory test exams will be offered.

252-0061-00L Systems Programming and Computer Architecture O 8 credits 4V+2U+1A T. Roscoe
Introduction to computer architecture and system programming:

Instruction sets, storage hierarchies, runtime structures with an emphasis on computers as engines for the execution of compiled programs. Interaction between system software and the hardware. Problems that arise from the final representation, performance measurement and tuning, and program portability issues are covered.

The objective is to allow students to understand all aspects of the execution of compiled (C) programs on modern architectures -- the instruction set, the storage resources (registers, stack, memory), input/output, the impact of compiler decisions, and the interaction between the operating system and hardware. Two main themes are correctness issues (esp. those that arise from the finite representation of data) and performance issues (incl. measurement and tuning issues). The interface to the operating system is discussed to prepare for subsequent classes on more advanced systems topics.

The two key goals are:

1) To equip students with a thorough understanding of how to write correct programs that run fast on modern computer, and
2) How to write correct and efficient low-level systems code.

This course does not cover how to design or build a processor or computer.

This course provides an overview of "computers" as a platform for the execution of (compiled) computer programs. This course provides a programmer's view of how computer systems execute programs, store information, and communicate. The course introduces the major computer architecture structures that have direct influence on the execution of programs (processors with registers, caches, other levels of the memory hierarchy, supervisor/kernel mode, and I/O structures) and covers implementation and representation issues only to the extent that they are necessary to understand the structure and operation of a computer system.

The course attempts to expose students to the practical issues that affect performance, portability, security, robustness, and extensibility. This course provides a foundation for subsequent courses on operating systems, networks, compilers and many other courses that require an understanding of the system-level issues. Topics covered include: machine-level code and its generation by optimizing compilers, address translation, input and output, trap/event handlers, performance evaluation and optimization (with a focus on the practical aspects of data collection and analysis).

The course is based in part on “Computer Systems: A Programmer's Perspective” (2nd Edition) by R. Bryant and D. O’Hallaron, with some additional material.

Prerequisites / notice
252-0024-00L Parallel Programming,
252-0014-00L Digital Circuits

Part 2

Number Title Type ECTS Hours Lecturers
252-0209-00L Algorithms, Probability, and Computing W 8 credits 4V+2U+1A E. Welzl, T. Holenstein, A. Steger

Abstract
Advanced design and analysis methods for algorithms and data structures: Random(ized) Search Trees, Point Location, Minimum Cut, Linear Programming, Randomized Algebraic Algorithms (matchings), Probabilistically Checkable Proofs (introduction).

Objective
Studying and understanding of fundamental advanced concepts in algorithms, data structures and complexity theory.

Lecture notes
Will be handed out.

Literature

Computer Science as Second Subject
Important: You can only enrol in the courses of subject didactics and professional training as a subsidiary subject if you have not more than 12 CP left for additional requirements.

Subject Didactics in Computer Science
Number Title Type ECTS Hours Lecturers
272-0101-00L Subject Didactics of Computer Science I O 4 credits 3G G. Serafini, J. Hromkovic

Abstract
Simultaneous enrollment in Introductory Practical in Computer Science - course 272-0201-00L - is compulsory.

The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.
The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support. They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

The objective is for the students:
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support. They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

The objective is for the students:
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- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

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In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.
Thematische Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Literatur
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

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

Professional Training in Computer Science

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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>271-0102-00L</td>
<td>Teaching Internship Including Examination Lessons in Computer Science</td>
<td>O</td>
<td>4 credits</td>
<td>9P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

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

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

Content

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature
Wird von der Praktikumslehrperson bestimmt.

Computer Science Teaching Diploma - Key for Type

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

<table>
<thead>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
Computer Science Master

► Interfocus Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>263-0006-00L</td>
<td>Algorithms Lab</td>
<td>O</td>
<td>6</td>
<td>4P+1A</td>
<td>A. Steger, E. Welzl, P. Widmayer</td>
</tr>
</tbody>
</table>

Abstract
Students learn how to solve algorithmic problems given by a textual description (understanding problem setting, finding appropriate modeling, choosing suitable algorithms, and implementing them). Knowledge of basic algorithms and data structures is assumed; more advanced material and usage of standard libraries for combinatorial algorithms are introduced in tutorials.

Objective
The objective of this course is to learn how to solve algorithmic problems given by a textual description. This includes appropriate problem modeling, choice of suitable (combinatorial) algorithms, and implementing them (using C/C++, STL, OGAL, and BGL).

Literature

263-0007-00L Advanced Systems Lab

Abstract
The goal of this course is to teach students how to evaluate the performance of complex computer and software systems. Accordingly, the methodology to carry out experiments and measurements is studied. Furthermore, the modelling of systems with the help of queueing network systems is explained.

Objective
The goal of this course is to teach students how to evaluate the performance of complex computer and software systems.

► Focus Courses

►► Focus Courses in Computational Science

►►► Focus Core Courses Computational Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>252-0523-00L</td>
<td>Computational Biology</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>G. H. Gonnet</td>
</tr>
</tbody>
</table>

Abstract
Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

Objective
Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

Content
This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

636-0007-00L Computational Systems Biology

Abstract
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content
Biological knowledge is an asset but not a prerequisite. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks. We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Literature

►► Focus Elective Courses Computational Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
</tr>
</tbody>
</table>

Abstract
Machine learning algorithms provide analytical methods to search data sets for characterizing patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

Abstract
This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.
Objective
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students’ curiosity to explore the field of computer graphics in subsequent courses or on their own.
Content
This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

263-5001-00L Introduction to Finite Elements and Sparse Linear System Solving W 4 credits 2V+1U P. Arbenz, T. Kaman
Abstract
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.
Objective
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.
Content
I. THE FINITE ELEMENT METHOD
   (1) Introduction, model problems.
   (2) 1D problems. Piecewise polynomials in 1D.
   (3) 2D problems. Triangulations. Piecewise polynomials in 2D.
   (4) Variational formulations. Galerkin finite element method.
   (5) Implementation aspects.
II. DIRECT SOLUTION METHODS
   (6) LU and Cholesky decomposition.
   (7) Sparse matrices.
   (8) Fill-reducing orderings.
III. ITERATIVE SOLUTION METHODS
   (9) Stationary iterative methods, preconditioning.
   (10) Preconditioned conjugate gradient method (PCG).
   (11) Incomplete factorization preconditioning.
   (12) Multigrid preconditioning.
   (13) Nonsymmetric problems (GMRES, BiCGstab).
   (14) Indefinite problems (SYMMLQ, MINRES).
Prerequisites / notice
Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.

263-5150-00L Scientific Databases W 4 credits 2V+1U G. H. Gonnet

Abstract
Scientific databases share many aspects with classical DBs, but have additional specific aspects. We will review Relational DBs, Object Oriented DBs, Knowledge DBs, textual DBs and the Semantic Web. All these topics will be studied from the point of view of the scientific applications (Bioinformatics, Physics, Chemistry, Health, Engineering) A toy SDB will be used for exercises.

Objective
The goals of this course are to:
(a) Familiarize the students with how existing DBs can be used for scientific applications.
(b) Recognize the areas where SciDBs differ and require additional features compared to classical DBs.
(c) Be able to understand more easily SciDBs, improve existing ones or design/create new ones.
(d) Familiarize the students with at least two examples of SciDBs.

Content
1) Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area.
   Hierarchy: File systems, data bases, knowledge bases and variations.
   Efficiency issues and how they differ from classical DB.
2) Relational DB used for scientific data, pros/cons
   Introduction to RDB, limitations of the model, basics of SQL,
   handling of metadata, examples of scientific use of RDBs.
3) Object Oriented DB. Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching.
   Space and access time efficiency of OODBs.
4) Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.
5) MapReduce / Hadoop
6) Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.
7) SGML and XML, human-readable databases, genomic databases.
   Advantages of human-readable databases (the huge initial success of genomic databases).
8) Semantic web, Resource Description Framework (RDF) triples, SparQL.
   An example of very flexible database for knowledge storage. Goals of the Semantic Web, discussion about its future.
9) An ideal scenario (and the design of a toy system with most of the desired features for exploration and exercises).
11) Functional testing, Verifiers, Consistency, Short-circuit testing, Recovery and Automatic recovery, Backup (incremental) methods.
12) Performance and space issues, various uses of compression, concurrency control. Hardware issues, clusters, Cloud computing, Crowd-sourcing.
13) Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

Literature
Several papers and online articles will be made available.
There is no single textbook for this course. A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences W 4 credits 3G J. Beck, P. Koumoutsakos

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.
Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

The goals of the course are, firstly, to give students a broader perspective on OS design than that provided by knowledge of Unix or Windows, building on the material in a standard undergraduate operating systems class, and, secondly, to provide them with practical experience in dealing directly with the concurrency, resource management, and abstraction problems confronting OS designers and implementers.

The first part of the lecture covers individual system’s aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. In the second part, the focus is on system design and methodologies for large projects.

Along the lectures, model cases will be elaborated and evaluated in the exercises.

The courses “Computer Graphics I and II” (GDV I & II) are recommended, but not mandatory.

The course consists of lectures, project work, and a written examination. Project work will be performed in small groups, where students will implement major components of a microkernel-based operating system. The final assessment will be a combination of project and examination grades.

The focus on system design and methodologies for large projects. The main question answered is how to get a large secure system. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security (java...), logging and auditing (BSM audit, dtrace, ...), cryptographic support, TCG, secure file systems, dos/windows/ windowsXP security issues.

Along the lectures, model cases will be elaborated and evaluated in the exercises.

Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversal, consistent snapshots, mutual exclusion, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.

Become acquainted with models and algorithms for distributed systems.
Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonome Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschließlich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Übertragungszeit von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuelle konstante Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen. Im einzelnen werden u.a. folgende Themen behandelt:

- Modelle verteilter Berechnungen; Raum-Zeit Diagramme; Virtuelle Zeit; Logische Uhren und Kausalität; Wellenalgorithmen; Verteilte und parallele Graphtraversierung; Berechnung konstituierter Schnappschüsse; Wechselfeldseitiger Ausschluss; Election und Symmetriebrechung;
- Verteilte Terminierung; Garbage-Collection in verteilten Systemen; Beobachten verteilter Systeme; Berechnung globaler Prädikate.

**Literature**

- F. Mattern: Verteilte Basinalgolithmen, Springer-Verlag
- G. Tel: Topics in Distributed Algorithms, Cambridge University Press
- G. Tel: Introduction to Distributed Algorithms, Cambridge University Press, 2nd edition
- N. Lynch: Distributed Algorithms, Morgan Kaufmann Publ

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**252-0817-00L Distributed Systems Laboratory**

In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. These Labs will only count towards the Master Programme. Additional Labs will be listed on the Addendum.

**Abstract**

This course involves the participation in a substantial development and/or evaluation project involving distributed systems technology. There are projects available in a wide range of areas: from web services to ubiquitous computing including wireless networks, ad-hoc networks, RFID, and distributed applications on smartphones.

**Objective**

Gain hands-on-experience with real products and the latest technology in distributed systems.

**Content**

There are projects available in a wide range of areas: from web services to ubiquitous computing including wireless networks, ad-hoc networks, and distributed application on smartphones. The goal of the project is for the students to gain hands-on-experience with real products and the latest technology in distributed systems. There is no lecture associated to the course.

For information of the course or projects available, please contact Prof. Mattern, Prof. Wattenhofer, Prof. Roscoe or Prof. G. Alonso.

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**Seminar Distributed Systems**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<td>252-0817-00L</td>
<td>Distributed Systems Laboratory</td>
<td>W</td>
<td>10</td>
<td>9P</td>
<td>M. Norrie</td>
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</table>

**Abstract**

This course involves the participation in a substantial development and/or evaluation project involving distributed systems technology. There are projects available in a wide range of areas: from web services to ubiquitous computing including wireless networks, ad-hoc networks, RFID, and distributed applications on smartphones. The goal of the project is for the students to gain hands-on-experience with real products and the latest technology in distributed systems. There is no lecture associated to the course.

**Objective**

Gain hands-on-experience with real products and the latest technology in distributed systems.

**Content**

There are projects available in a wide range of areas: from web services to ubiquitous computing including wireless networks, ad-hoc networks, and distributed application on smartphones. The goal of the project is for the students to gain hands-on-experience with real products and the latest technology in distributed systems. There is no lecture associated to the course.

For information of the course or projects available, please contact Prof. Mattern, Prof. Wattenhofer, Prof. Roscoe or Prof. G. Alonso.

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**Focus Courses in Information Security**

**Focus Core Courses Information Security**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>252-0463-00L</td>
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<td>W</td>
<td>5</td>
<td>2V+2U</td>
<td>D. Basin</td>
</tr>
</tbody>
</table>

**Abstract**

Subject of the class are engineering techniques for developing secure systems. We examine concepts, methods and tools, applied within the different activities of the SW development process to improve security of the system. Topics: security requirements & risk analysis, system modeling & model-based development methods, implementation-level security, and evaluation criteria for secure systems.

**Objective**

Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

**Topics covered include**

- security requirements & risk analysis,
- system modeling and model-based development methods,
- implementation-level security, and
- evaluation criteria for the development of secure systems

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Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems

Modules taught:

1. Introduction
   - Introduction of Infsec group and speakers
   - Security meets SW engineering: an introduction
   - The activities of SW engineering, and where security fits in
   - Overview of this class
2. Requirements Engineering: Security Requirements and some Analysis
   - overview: functional and non-functional requirements
   - use cases, misuse cases, sequence diagrams
   - safety and security
   - FMEA, FTA, attack trees
3. Modeling in the design activities
   - structure, behavior, and data flow
   - class diagrams, statecharts
4. Model-driven security for access control (design)
   - SecureUML as a language for access control
   - Combining Design Modeling Languages with SecureUML
   - Semantics, i.e., what does it all mean,
   - Generation
   - Examples and experience
5. Model-driven security (Part II)
   - Continuation of above topics
6. Security patterns (design and implementation)
7. Implementation-level security
   - Buffer overflows
   - Input checking
   - Injection attacks
8. Testing
   - overview
   - model-based testing
   - testing security properties
9. Risk analysis and management 1 (project management)
   - "risk": assets, threats, vulnerabilities, risk
   - risk assessment: quantitative and qualitative
   - safeguards
   - generic risk analysis procedure
   - The OCTAVE approach
10. Risk analysis: IT baseline protection
    - Overview
    - Example
11. Evaluation criteria
    - CMM
    - systems security engineering CMM
    - common criteria
12. Guest lecture
    - TBA

Literature
- Further relevant books and journal/conference articles will be announced in the lecture.

Prerequisites / notice
Prerequisite: Class on Information Security
The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions, ACLs, network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for large projects. The main question answered is how to get a large secure system. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security (java...), logging and auditing (BSM audit, dtrace,...), cryptographic support, TCG, secure file systems, dos/windows/windowsXP security issues.

Along the lectures, model cases will be elaborated and evaluated in the exercises.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0811-00L</td>
<td>Applied Security Laboratory</td>
<td>W</td>
<td>8</td>
<td>7P</td>
<td>D. Basin</td>
</tr>
</tbody>
</table>

Abstract
Hands-on course on applied aspects of information security. Applied information security, operating system security. QoS hardening, computer forensics, web application security, project work, design, implementation, and configuration of security mechanisms, risk analysis, system review.

Objective
The Applied Security Laboratory addresses four major topics: operating system security (hardening, vulnerability scanning, access control, logging), application security with an emphasis on web applications (web server setup, common web exploits, authentication, session handling, code security), computer forensics, and risk analysis and risk management.

Content
This course emphasizes applied aspects of Information Security. The students will study a number of topics in a hands-on fashion and carry out experiments in order to better understand the need for secure implementation and configuration of IT systems and to assess the effectivity and impact of security measures. This part is based on a book and virtual machines that include example applications, questions, and answers.

The students will also complete an independent project: based on a set of functional requirements, they will design and implement a prototypical IT system. In addition, they will conduct a thorough security analysis and devise appropriate security measures for their systems. Finally, they will carry out a technical and conceptual review of another system. All project work will be performed in teams and must be properly documented.

Lecture notes
The course is based on the book "Applied Information Security - A Hands-on Approach". More information:
http://www.infsec.ethz.ch/appliedlabbook

Literature
Recommended reading includes:
* Various: OWASP Guide to Building Secure Web Applications, available online
* O'Reilly, Loukides: Unix Power Tools, O'Reilly & Associates.
* Frisch: Essential System Administration, O'Reilly & Associates.
* NIST: Risk Management Guide for Information Technology Systems, available online as PDF
* BSI: IT-Grundschutzhandbuch, available online

Prerequisites / notice
* The lab allows flexible working since there are only few mandatory meetings during the semester.
* The lab covers a variety of different techniques. Thus, participating students should have a solid foundation in the following areas: information security, operating system administration (especially Unix/Linux), and networking. Students are also expected to have a basic understanding of HTML, PHP, JavaScript, and MySQL because several examples are implemented in these languages.
* Students must be prepared to spend more than three hours per week to complete the lab assignments and the project. This applies particularly to students who do not meet the recommended requirements given above. Successful participants of the course receive 8 credits as compensation for their effort.
* All participants must sign the lab's charter and usage policy during the introduction lecture.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-1411-00L</td>
<td>Security of Wireless Networks</td>
<td>W</td>
<td>5</td>
<td>2V+1U+1A</td>
<td>S. Capkun</td>
</tr>
</tbody>
</table>

Abstract
Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques.

Objective
After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.

Content

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-4630-00L</td>
<td>Computer-Aided Modelling and Reasoning</td>
<td>W</td>
<td>8</td>
<td>7P</td>
<td>A. Lochbihler, C. Sprenger</td>
</tr>
</tbody>
</table>

Abstract
The "computer-aided modelling and reasoning" lab is a hands-on course about using an interactive theorem prover to construct formal models of algorithms, protocols, and programming languages and to reason about their properties. The lab has two parts: The first introduces various modelling and proof techniques. The second part consists of a project in which the students apply these techniques.

Objective
The students learn to effectively use a theorem prover to create unambiguous models and rigorously analyse them. They learn how to write precise and concise specifications, to exploit the proof assistant as a tool for checking and analysing such models and for taming their complexity, and to extract certified executable implementations from such specifications.

Content
The "computer-aided modelling and reasoning" lab is a hands-on course about using an interactive theorem prover to construct formal models of algorithms, protocols, and programming languages and to reason about their properties. The focus is on applying logical methods to concrete problems supported by a theorem prover. The course will demonstrate the challenges of formal rigor, but also the benefits of machine support in modelling, proving and validating.

The lab will have two parts: The first part introduces basic and advanced modelling techniques (functional programs, inductive definitions, modules), the associated proof techniques (term rewriting, resolution, induction, proof automation), and compilation of the models to certified executable code. In the second part, the students work in teams of two on a project assignment in which they apply these techniques: they build a formal model and prove its desired properties. The project lies in the area of programming languages, model checking, or information security.
Network Security

ECTS: 6
Lecture: 2V+1U+2P
Prerequisites: Students are assumed to have knowledge in networking as taught in the Communication Networks lecture. This lecture is intended for students with an interest in securing Internet services and networked devices. Students are expected to read a scientific paper and present it in a 35-40 min talk. At the beginning of the semester a short introduction to practicing presentation techniques will be given.

Abstract
This lecture discusses fundamental concepts and technologies in the area of network security. Several case studies illustrate the dark side of the Internet and explain how to protect against such threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

Objective
Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures. Students can identify and assess known vulnerabilities in a software system that is connected to the Internet. Students know fundamental network security concepts. Students have an in-depth understanding of important security technologies. Students know how to configure a real firewall and know some penetration testing tools from their own experience.

Content
Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

Literature
Knowledge in computer networking and Internet protocols (e.g. course Communication Networks (D-ITET) or Operating Systems and Networks (D-INFK)).

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

Seminar Information Security

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-4601-00L</td>
<td>Current Topics in Information Security</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>D. Basin, S. Capkun, A. Perrig</td>
</tr>
</tbody>
</table>

Abstract
The seminar covers various topics in information security: security protocols (models, specification & verification), trust management, access control, non-interference, side-channel attacks, identity-based cryptography, host-based attack detection, anomaly detection in backbone networks, key-management for sensor networks.

Objective
The main goals of the seminar are the independent study of scientific literature and assessment of its contributions as well as learning and practicing presentation techniques.

Content
The seminar covers various topics in information security, including network security, cryptography and security protocols. The participants are expected to read a scientific paper and present it in a 35-40 min talk. At the beginning of the semester a short introduction to presentation techniques will be given.

Selected Topics
- security protocols: models, specification & verification
- trust management, access control and non-interference
- side-channel attacks
- identity-based cryptography
- host-based attack detection
- anomaly detection in backbone networks
- key-management for sensor networks

Literature
The reading list will be published on the course web site.

Focus Courses in Information Systems

Focus Core Courses Information Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
</tr>
</tbody>
</table>

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature
Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

252-0463-00L Security Engineering W 5 credits 2V+2U D. Basin

Abstract
Subject of the class are engineering techniques for developing secure systems. We examine concepts, methods and tools, applied within the different activities of the SW development process to improve security of the system. Topics: security requirements & risk analysis, system modeling & model-based development methods, implementation-level security, and evaluation criteria for secure systems.

Objective
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.
Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include
- security requirements & risk analysis,
- system modeling and model-based development methods,
- implementation-level security, and
- evaluation criteria for the development of secure systems

Content
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.
Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include
- security requirements & risk analysis,
- system modeling and model-based development methods,
- implementation-level security, and
- evaluation criteria for the development of secure systems

Modules taught:

1. Introduction
   - Introduction of Infsec group and speakers
   - Security meets SW engineering: an introduction
   - The activities of SW engineering, and where security fits in
   - Overview of this class
2. Requirements Engineering: Security Requirements and some Analysis
   - overview: functional and non-functional requirements
   - use cases, misuse cases, sequence diagrams
   - safety and security
   - FMEA, FTA, attack trees
3. Modeling in the design activities
   - structure, behavior, and data flow
   - class diagrams, statecharts
4. Model-driven security for access control (design)
   - SecureUML as a language for access control
   - Combining Design Modeling Languages with SecureUML
   - Semantics, i.e., what does it all mean,
   - Generation
   - Examples and experience
5. Model-driven security (Part II)
   - Continuation of above topics
6. Security patterns (design and implementation)
7. Implementation-level security
   - Buffer overflows
   - Input checking
   - Injection attacks
8. Testing
   - overview
   - model-based testing
   - testing security properties
9. Risk analysis and management 1 (project management)
   - "risk": assets, threats, vulnerabilities, risk
   - risk assessment: quantitative and qualitative
   - safeguards
   - generic risk analysis procedure
   - The OCTAVE approach
10. Risk analysis: IT baseline protection
    - Overview
    - Example
11. Evaluation criteria
    - CMMI
    - systems security engineering CMM
    - common criteria
12. Guest lecture
    - TBA
The goals of this course are to:

- Familiarize the students with how existing DBs can be used for scientific applications.
- Recognize the areas where SciDBs differ and require additional features compared to classical DBs.
- Be able to understand more easily SciDBs, improve existing ones or design/create new ones.
- Familiarize the students with at least two examples of SciDBs.

Prerequisite: Class on Information Security
Content

1) - Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area. Hierarchy: File systems, data bases, knowledge bases and variations. Efficiency issues and how they differ from classical DB.

2) - Relational DB used for scientific data, pros/cons Introduction to RDB, limitations of the model, basics of SQL, handling of metadata, examples of scientific use of RDBs.

3) - Object Oriented DB. Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching. Space and access time efficiency of OOBs.

4) - Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.

5) - MapReduce / Hadoop

6) - Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.

7) - SGML and XML, human-readable databases, genomic databases. Advantages of human-readable databases (the huge initial success of genomic databases).

8) - Semantic web, Resource Description Framework (RDF) triples, SparQL. An example of very flexible database for knowledge storage. Goals of the Semantic Web, discussion about its future.

9) - An ideal scenario (and the design of a toy system with most of the desired features for exploration and exercises).


11) - Functional testing, Verifiers, Consistency, Short-circuit testing. Recovery and Automatic recovery, Backup (incremental) methods.

12) - Performance and space issues, various uses of compression, concurrency control. Hardware issues, clusters, Cloud computing, Crowd-sourcing.

13) - Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

Literature

Several papers and online articles will be made available.

There is no single textbook for this course. A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

263-5200-00L Data Mining: Learning from Large Data Sets W 4 credits 2V+1U A. Krause

Abstract

Many scientific and commercial applications require insights from massive, high-dimensional data sets. This courses introduces principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course both covers theoretical foundations and practical applications.

Objective

Many scientific and commercial applications require us to obtain insights from massive, high-dimensional data sets. In this graduate-level course, we will study principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will both cover theoretical foundations and practical applications.

Content

Topics covered:
- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems

Prerequisites / notice

Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

263-5210-00L Probabilistic Artificial Intelligence W 4 credits 2V+1U A. Krause

Abstract

This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

Objective

How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.

Content

Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximate inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites / notice

Solid basic knowledge in statistics, algorithms and programming
After successfully taking this course, students will have a theoretical and practical understanding of:

- Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection

Objective:
The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.

Content:
Each participant will be required to give a presentation of about 30 mins followed by a discussion on an assigned topic. In addition, each participant will be assigned as a buddy on another paper which means that they must read the paper and be prepared to start of the discussion on the paper with some comments and questions. Students also have to submit a 2-page summary of the paper that they present. Grading will depend on the quality of the talk, the report, and also active participation during the seminar.

Focus Courses in Software Engineering

Focus Core Courses Software Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0237-00L</td>
<td>Concepts of Object-Oriented Programming</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>P. Müller</td>
</tr>
</tbody>
</table>
|                 | Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection
| Abstract        |                                                                                   |
| Objective       | After this course, students will:                                                |
|                 | Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features. |
|                 | Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs. |
|                 | Be able to learn new languages more rapidly.                                      |
|                 | Be aware of many subtle problems of object-oriented programming and know how to avoid them. |
| Content         | The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages. |
| Literature      | The topics discussed in the course include among others:                          |
|                 | The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing) |
|                 | The key problems of single and multiple inheritance and how different languages address them |
|                 | Generic type systems, in particular, Java generics, C# generics, and C++ templates |
|                 | The situations in which object-oriented programming does not provide encapsulation, and how to avoid them |
|                 | The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing |
|                 | How to maintain the consistency of data structures |
| Prerequisites / notice |                                                                                   |
| Literature      | Will be announced in the lecture.                                                |
| Prerequisites:  | Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming); programming experience |

| 252-0239-00L    | Software Verification             | W    | 6    | 3V+2U  | B. Meyer, C. A. Furia, S. Nanz |
|                 | This course surveys some of the main approaches to software verification, including axiomatic semantics, abstract interpretation, model checking, and testing. |
| Abstract        | After successfully taking this course, students will have a theoretical and practical understanding of: |
|                 | * The principles behind fundamental software verification techniques, including Hoare-style axiomatic semantics, abstract interpretation, model checking, and testing. |
|                 | * Application of the principles to the construction of verification tools, in particular program provers. |
|                 | * Research challenges in these areas.                                             |
| Content         | The idea of software verification has been around for decades, but only recently have the techniques become mature enough to be implemented and be applicable in practice. Progress has been made possible by the convergence of different techniques, originally developed in isolation. |
|                 | This course embraces this diversity of approaches, by surveying some of the main ideas, techniques, and results in software verification. These include in particular: |
|                 | * Axiomatic semantics, which provides a foundation of program correctness proofs by supplying a rigorous semantics of programs. |
|                 | * Abstract interpretation, which provides a general framework to express and design static techniques for program analysis. |
|                 | * Model checking, which provides efficient techniques for the exhaustive exploration of state-based models of programs and reactive systems. |
|                 | * Testing, which provides the counterpart to exhaustive techniques by defining dynamic analyses to detect programming mistakes and correct them. |
|                 | To demonstrate some of the techniques in practice, the course will offer a practical project requiring the application of verification tools to illustrative examples. |
Literature

Axiomatic semantics:


Abstract interpretation:

* Neil D. Jones, Flemming Nielson: Abstract Interpretation: a Semantic-Based Tool for Program Analysis

Model checking and real-time:


Testing:


263-2800-00L Design of Parallel and High-Performance Computing

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0273-01L</td>
<td>Distributed Software Engineering Laboratory</td>
<td>W</td>
<td>8</td>
<td>2V+3A</td>
<td>B. Meyer, P. Kolb, D. M. Nordio</td>
</tr>
</tbody>
</table>

Abstract
The Distributed Software Engineering Laboratory introduces the software engineering principles and techniques appropriate for the increasingly prevalent style of modern software development, involving teams spread across teams, companies and countries.

Objective
Modern software development is increasingly "distributed": projects are developed by different groups collaborating across teams, companies, countries, timezones. This setup radically alters the assumptions underlying many of the traditional views of software engineering.

Content
Basics of distributed development
The outsourcing phenomenon; country review.
Requirements engineering for distributed projects
Quality assurance for distributed projects.
Process models (especially CMMI) and agile methods
Supplier assessment and qualification.
Negotiating a contract for a distributed project.
Software project management for distributed projects.
Role of interfaces and other technical issues of distributed development.
A key part of the Laboratory is the course project, performed in groups involving teams from other universities. Students get to practice distributed development directly, experiencing issues and applying techniques presented in the course.

Lecture notes
The exercise sessions usually start at 9am.

Prerequisites / notice
The course page includes the full set of slides and links to supplementary documentation.
Prerequisites: Basic understanding of programming.

252-0286-00L System Construction

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0286-00L</td>
<td>System</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>F. O. Friedrich</td>
</tr>
</tbody>
</table>

Abstract
Main goal is teaching knowledge and skills needed for building custom operating systems and runtime environments. Relevant topics are studied at the example of sufficiently simple systems that have been built at our Institute in the past, ranging from purpose-oriented single processor real-time systems up to generic system kernels on multi-core hardware.
Objective

The lecture's main goal is teaching of knowledge and skills needed for building custom operating systems and runtime environments.

The lecture intends to supplement more abstract views of software construction, and to contribute to a better understanding of "how it really works" behind the scenes.

Content

Case Study 1: Embedded System
- Safety-critical and fault-tolerant monitoring system
- Based on an auto-pilot system for helicopters

Case Study 2: Multi-Processor Operating System
- Universal operating system for symmetric multiprocessors
- Shared memory approach
- Based on Language-/System Codesign (Active Oberon / A2)

Case Study 3: Custom designed Single-Processor System
- RISC Single-processor system designed from scratch
- Hardware on FPGA
- Graphical workstation OS and compiler (Project Oberon)

Case Study 4: Custom-designed Multi-Processor System
- Special purpose heterogeneous system on a chip
- Massively parallel hard- and software architecture based on message passing
- Focus: dataflow based applications

Lecture notes

Printed lecture notes will be delivered during the lecture. Slides will also be available from the lecture homepage.

263-2600-00L Robotics Programming Laboratory
Number of participants limited to 18.

The course is open to students of computer science, electrical engineering, and mechanical engineering background (although students from other departments will be considered).

In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. Additional Labs will be listed on the Addendum.

Abstract

This course is a hands-on laboratory course in which participants program Thymio II robot that will play in a competition. Students will learn software engineering skills and robotics concepts and apply them in practice.

Objective

- Knowledge of basic software engineering principles and methods
- Knowledge of how software engineering applies to robotics
- Knowledge of the most common architectures, coordination and synchronization methods
- Experience in design of a small robotics system with aspects of sensing, planning and control

Content

- Software engineering tools
- Design patterns
- Software architecture
- ROS and Roboscoop
- Perception
- Mapping and localization
- Path planning and obstacle avoidance

Prerequisites / notice

Students will program Thymio II educational robot with a Carmine 1.09 RGBD camera as the sensor.

Combination of lectures and a semester-long project.

Prior programming experience required. Object-oriented programming (especially Eiffel and C++) strongly recommended. Experience with Linux helpful.

Limited to 18 students.
- Expected to work both individually and in teams of 2-3 students

263-4630-00L Computer-Aided Modelling and Reasoning

In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. Additional Labs will be listed on the Addendum.

Abstract

The "computer-aided modelling and reasoning" lab is a hands-on course about using an interactive theorem prover to construct formal models of algorithms, protocols, and programming languages and to reason about their properties. The lab has two parts: The first introduces various modelling and proof techniques. The second part consists of a project in which the students apply these techniques.

Objective

The students learn to effectively use a theorem prover to create unambiguous models and rigorously analyse them. They learn how to write precise and concise specifications, to exploit the proof assistant as a tool for checking and analysing such models and for taming their complexity, and to extract certifiable executable implementations from such specifications.

Content

- Software engineering tools
- Design patterns
- Software architecture
- ROS and Roboscoop
- Perception
- Mapping and localization
- Path planning and obstacle avoidance

The lab will have two parts: The first part introduces basic and advanced modelling techniques (functional programs, inductive definitions, modules), the associated proof techniques (term rewriting, resolution, induction, proof automation), and compilation of the models to certified executable code. In the second part, the students work in teams of two on a project assignment in which they apply these techniques: they build a formal model and prove its desired properties. The project lies in the area of programming languages, model checking, or information security.

Seminar Software Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-2100-00L</td>
<td>Research Topics in Software Engineering</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>P. Müller</td>
</tr>
</tbody>
</table>

Abstract

This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.

Objective

Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).
The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering. To accomplish that, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools.

The publications to be presented will be announced on the seminar home page at least one week before the first session.

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar's home page for information.

### Focus Courses in Theoretical Computer Science

#### Focus Core Courses Theoretical Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0417-00L</td>
<td>Randomized Algorithms and Probabilistic Methods</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>A. Steger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Las Vegas &amp; Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks</td>
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<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Randomized Algorithms are algorithms that &quot;flip coins&quot; to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.</td>
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<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
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<tr>
<td>Objective</td>
<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<tr>
<td>Content</td>
<td>The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<tr>
<td>Lecture notes</td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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<td></td>
<td>Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.</td>
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<tr>
<td>252-1407-00L</td>
<td>Algorithmic Game Theory</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>P. Widmayer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.</td>
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<td>Objective</td>
<td>Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.</td>
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<tr>
<td>Content</td>
<td>The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.</td>
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<td>This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.</td>
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<tr>
<td>Outline</td>
<td>Introduction to classical game theoretic concepts.</td>
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<td></td>
<td>Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.</td>
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<td></td>
<td>The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the &quot;price of anarchy&quot;.</td>
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<td></td>
<td>Auction-like mechanisms and algorithms that &quot;direct&quot; the actions of selfish agents into a certain desired equilibrium situation.</td>
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<td>Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks</td>
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<tr>
<td>Lecture notes</td>
<td>No lecture notes.</td>
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Focus Elective Courses Theoretical Computer Science

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-1425-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>B. Gärtner, M. Hoffmann, E. Welzl</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)</td>
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<tr>
<td>252-4050-00L</td>
<td>Complexity Theory</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>T. Holenstein</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Complexity Theory classifies problems according to the resources required in order to solve them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, NP, AM, PH, PSPACE, IP, EXP), and study circuit complexity.</td>
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<tr>
<td>401-3901-00L</td>
<td>Mathematical Optimization</td>
<td>W</td>
<td>11</td>
<td>4V+2U</td>
<td>R. Weismantel</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Mathematical treatment of diverse optimization techniques.</td>
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Seminar Theoretical Computer Science

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>263-4200-00L</td>
<td>Seminar SAT</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>E. Welzl</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Study and presentation of research papers from the literature on “Boolean Satisfiability-Combinatorics and Algorithms”.</td>
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<tr>
<td>252-4202-00L</td>
<td>Seminar in Theoretical Computer Science</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>E. Welzl, B. Gärtner, J. Lengler, A. Steger, B. Sudakov</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.</td>
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<tr>
<td>263-4203-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>B. Gärtner, E. Welzl</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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</table>
|               | The seminar is held once a year and complements the courses Computational Geometry and Geometric Graphs: Combinatorics & Algorithms. Students of the seminar will present original research papers, some classic and some of them very recent. The seminar is a good preparation for a master, diploma, or semester thesis in the area.
Each student is expected to read, understand, and elaborate on a selected research paper. To this end, (s)he should give a 45-min. presentation about the paper. The process includes

* getting an overview of the related literature;
* understanding and working out the background/motivation: why and where are the questions addressed relevant?
* understanding the contents of the paper in all details;
* selecting parts suitable for the presentation;
* presenting the selected parts in such a way that an audience with some basic background in geometry and graph theory can easily understand and appreciate it.

To attend the seminar, some basic knowledge in (discrete and computational) geometry and graphs and algorithms is required. Thus, previous participation in some of the courses “Graphs and Algorithms”, “Computational Geometry”, “Geometric Graphs: Combinatorics & Algorithms”, or similar courses is strongly encouraged. It is also possible to take this seminar in parallel to the lecture “Computational Geometry”.

### Focus Courses in Visual Computing

#### Focus Core Courses Visual Computing

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
</tr>
</tbody>
</table>

**Abstract**

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

**Objective**

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

**Content**

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

**Lecture notes**

No lecture notes, but slides will be made available on the course webpage.

**Literature**


**Prerequisites / notice**

Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

**Abstract**

This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

**Objective**

At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.

**Content**

This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

**Lecture notes**

No lecture notes.

**Prerequisites / notice**

Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended.

The programming assignments will be in C++. This will not be taught in the class.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>263-5902-00L</td>
<td>Computer Vision</td>
<td>W</td>
<td>6 credits</td>
<td>3V+1U+1A</td>
<td>M. Pollefeys, L. Van Gool</td>
</tr>
</tbody>
</table>

**Abstract**

The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

**Objective**

The objectives of this course are:

1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

**Content**

Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

**Prerequisites / notice**

It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.
Focus Elective Courses Visual Computing

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0546-00L</td>
<td>Physically-Based Simulation in Computer Graphics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>B. Solenthaler, B. Thomaszewski</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.</td>
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<tr>
<td>Objective</td>
<td>The lecture offers an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.</td>
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<tr>
<td>Content</td>
<td>The lecture covers topics in physically-based modeling, such as particle systems, mass-spring models, finite difference and finite element methods. These approaches are used to represent and simulate deformable objects or fluids with applications in animated movies, 3D games and medical systems. Furthermore, the lecture covers topics such as rigid body dynamics, collision detection, and character animation.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Fundamentals of calculus and physics, basic concepts of algorithms and data structures, basic programming skills in C++. Knowledge on numerical mathematics as well as ordinary and partial differential equations is an asset, but not required.</td>
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| 252-5703-00L| Multimedia Communications | W    | 4    | 2V+1U | A. Smolic |
| Abstract    | After a summary of fundamentals in signal processing and information theory, an introduction to processing and coding of different types of multimedia is given. |
| Objective   | Understanding principles of multimedia communications and getting an illustrative overview of available and emerging technology. |
| Content     | After a summary of fundamentals in signal processing and information theory, an introduction to processing and coding of different types of multimedia is given. This starts with speech (PCM, vocoder, CELP etc.), continues over audio (MP3, AAC etc.), still images (JPEG etc.), video (MPEG-2, MPEG-4, H.264/AVC, HEVC etc.), and interactive graphics (MPEG-4), to emerging and future multimedia content such as 3D video, free viewpoint video, high dynamic range video. Algorithms as well as human perception will be addressed. |
| Prerequisites / notice | Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required. |

| 263-5200-00L| Data Mining: Learning from Large Data Sets  | W    | 4    | 2V+1U | A. Krause |
| Abstract    | Many scientific and commercial applications require insights from massive, high-dimensional data sets. This lecture introduces principles, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course lecture covers theoretical foundations and practical applications. |
| Objective   | Many scientific and commercial applications require us to obtain insights from massive, high-dimensional data sets. In this graduate-level course, we will study principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will cover both theoretical foundations and practical applications. |
| Content     | Topics covered: - Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk) - Fast nearest neighbor methods (Shingling, locality sensitive hashing) - Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines) - Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback) - Active learning (uncertainty sampling, pool-based methods, label complexity) - Dimension reduction (random projections, nonlinear methods) - Data streams (Sketches, coresets, applications to online clustering) - Recommender systems |
| Prerequisites / notice | Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required. |

| 263-5210-00L| Probabilistic Artificial Intelligence  | W    | 4    | 2V+1U | A. Krause |
| Abstract    | This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. |
| Objective   | How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students. |
| Content     | Topics covered: - Search (BFS, DFS, A*), constraint satisfaction and optimization - Tutorial in logic (propositional, first-order) - Probability - Bayesian Networks (models, exact and approximative inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks) - Probabilistic planning (MDPs, POMDPs) - Reinforcement learning - Combining logic and probability |
| Prerequisites / notice | Solid basic knowledge in statistics, algorithms and programming |

| 252-0527-00L| Probabilistic Graphical Models for Image Analysis | W    | 4    | 3G    |
| Abstract    | This course will focus on the algorithms for inference and learning with statistical models. We use a framework called probabilistic graphical models which include Bayesian Networks and Markov Random Fields. |
| Objective   | We will use examples from traditional vision problems such as image registration and image segmentation, as well as recent problems such as object recognition. |
| Literature  | Students will be introduced to probabilistic graphical models and will learn how to apply them to problems in image analysis and understanding. The focus will be to study various algorithms for inference and parameter learning. |

Seminar Visual Computing
The lecture covers the role of ICT for sustainable energy usage. Concepts of the emerging smart grid are outlined and approaches to

Content
The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.

Literature
The papers will be presented in the first session of the seminar.

252-5051-00L Advanced Topics in Machine Learning ■

Abstract
In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning.

Objective
The seminar “Advanced Topics in Machine Learning” familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of a seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.

Content
The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.

Literature
The papers will be presented in the first session of the seminar.

252-5701-00L Advanced Topics in Computer Graphics and Vision

Abstract
This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.

Objective
The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills.

Content
This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers are selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics. All students read the papers and participate in the discussion.

Lecture notes
no script

Literature
Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

Prerequisites / notice
The courses "Computer Graphics I and II" (GDV I & II) are recommended, but not mandatory.

Computer Science Elective Courses
The Elective Computer Science Courses can be selected from all Master level courses offered by D-INFK.

Number Title Type ECTS Hours Lecturers
252-0293-00L Wireless and Mobile Computing for Entertainment Applications W 4 credits 2V+1U S. Mangold

Abstract
This course gives a detailed overview about the 802 standards and summarizes the state of the art for WLANs, WPANs, and WMANs, including new topics such as mesh networks, cognitive radio, and visible light communications. The course combines lectures with a set of assignments in which students are asked to work with a simple JAVA simulation software.

Objective
The objective of the course is to learn about the general principles of wireless communications, including physics, frequency spectrum regulation, and standards. Further, the most up-to-date standards and protocols used for wireless LAN IEEE 802.11, Bluetooth and Wi-Fi, mesh networks, sensor networks, cellular networks, visible light communication, and cognitive radios, are analyzed and evaluated. Students develop their own add-on mobile computing algorithms to improve the behavior of the systems, using a JAVA-based event-driven simulator. We also hand out embedded systems that can be used for experiments for optical communication.

Content

Lecture notes
The script will be made available from the course webpage.

(1) The course blog at http://blogs.ethz.ch/stefanmangold/
(2) The course webpage at http://www.lst.inf.ethz.ch/teaching/lectures/hs14/293/index.html
(3) The JAVA simulation kernel "jemula"
(4) The JAVA 802 protocol emulator "JEmula802"

Prerequisites / notice
Students should have interest in wireless communication, and should be familiar with JAVA programming.

252-3610-00L Smart Energy

Abstract
The lecture covers the role of ICT for sustainable energy usage. Concepts of the emerging smart grid are outlined and approaches to motivate sustainable consumer choices are explained. The lecture combines technologies from ubiquitous computing and traditional ICT with insights from socio-psychological concepts and illustrates them with examples from actual applications.

Objective
Participants become familiar with the challenges related to sustainable energy usage, understand the principles of a smart grid infrastructure and its applications, know the role of ubiquitous computing technologies, can explain the challenges regarding security and privacy, can reflect the basics cues to induce changes in consumer behavior, develop a general understanding of the effects of a smart grid on energy efficiency, and know how to apply the learning to related design projects.

Content
- Background on energy generation and consumption; characteristics, potential, and limitations of renewable energy sources
- Introduction to energy economics
- Smart grid and smart metering infrastructures, virtual power plants, security challenges
- Demand management and home automation using ubiquitous computing technologies
- Changing consumer behavior with smart ICT
- Benefits challenges of a smart energy system

Literature
Will be provided during the course, though a good starting point is “ICT for green: how computers can help us to conserve energy” from Friedemann Mattern, Thosten Staake, and Markus Weiss (available at http://www.vs.inl.ethz.ch/publ/papers/ICT-for-Green.pdf).
**Elective Courses**

Students can individually choose from the entire Master course offerings from ETH Zurich, EPF Lausanne, the University of Zurich and - with the consent of the mentor - from all other Swiss universities.

For further details, refer to Art. 31 of the Regulations 2009 for the Master Program in Computer Science.

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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>263-0600-00L</td>
<td>Research in Computer Science [W]</td>
<td>5 credits</td>
<td>11A</td>
<td>Professors</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Independent project work under the supervision of a Computer Science Professor.</td>
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<tr>
<td>Objective</td>
<td>Independent project work under the supervision of a Computer Science Professor.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Only students who fulfill one of the following requirements are allowed to begin a research project: a) 1 lab (interfocus course) and 1 focus course b) 2 core focus courses c) 2 labs (interfocus courses)</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>A task description must be submitted to the Student Administration Office at the beginning of the work.</td>
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</tbody>
</table>

| 227-0778-00L | Hardware/Software Codesign [W] | 6 credits | 2V+2U | L. Thiele |
| Abstract | The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components. |
| Objective | The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components. |
| Content | The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and re-targetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware/software partitioning and design space exploration). |
| Prerequisites / notice | Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded systems |

| 227-0327-00L | GIS III [W] | 5 credits | 3G | P. Kiever, S. Scheider |
| Abstract | The course deals with advanced topics in GIS: GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services: technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS. |
| Objective | Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services. |
| Lecture notes | no script |

**Internship**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0700-00L</td>
<td>Internship [W]</td>
<td>0 credits</td>
<td></td>
<td></td>
<td>external organisers</td>
</tr>
<tr>
<td>Abstract</td>
<td>The internship must be at least 10 weeks long and can be undertaken in a Swiss or a foreign company.</td>
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<tr>
<td>Objective</td>
<td>An internship provides opportunities to gain experience in an industrial environment and creates a network of contacts.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>To register the internship, please submit a document to the Student Administration Office containing the following information at the latest two weeks after beginning the internship: - a detailed task description: task, technologies, milestones etc. - start and end date of the internship - supervisor: name and academic degree</td>
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</tbody>
</table>

**Compulsory Electives in Humanities, Social and Political Sciences**

Recommended GESS compulsory elective courses (Type B) for D-INFK:

- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses ETH/UZH

**Master Thesis**
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-0800-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- successful completion of the bachelor programme;
- fulfilling of any additional requirements necessary to gain admission to the master programme.

**Abstract**
Independent project work supervised by a Computer Science professor. Duration 6 months.

**Objective**
Independent project work supervised by a Computer Science professor.

<table>
<thead>
<tr>
<th>Computer Science Master - Key for Type</th>
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<tbody>
<tr>
<td>O</td>
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<tr>
<td>W+</td>
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<tr>
<td>W</td>
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</table>

<table>
<thead>
<tr>
<th>Key for Hours</th>
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<tbody>
<tr>
<td>V</td>
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<tr>
<td>G</td>
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<tr>
<td>U</td>
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<tr>
<td>S</td>
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<tr>
<td>K</td>
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</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0010-00L</td>
<td>Chemistry</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>A. de Mello, K. Ehlira</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is a general chemistry course aimed at first year undergraduate students in the Department of Mechanical and Process Engineering (D-MAVT).</td>
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</tbody>
</table>
| Objective     | The aims of the course are as follows:  
1) To provide a thorough understanding of the basic principles of chemistry and its application.  
2) To develop an understanding of the atomic and molecular nature of matter and of the chemical reactions that describe their transformations.  
3) To emphasize areas considered most relevant in an engineering context. |
| Content       | Electronic structure of atoms, chemical bonding, molecular shape and bonding theory, gases, thermodynamics, chemical thermodynamics, chemical kinetics, equilibria, solutions and intermolecular forces, redox and electrochemistry. |
| Literature    | The course is based on "Chemistry the Central Science" by Brown, LeMay, Bursten, Murphy and Woodward. Pearson. 12th Edition (international edition). |
| 051-0757-00L  | Building Process I                 | W    | 2 credits | 2G    | S. Menz               |
| Abstract      | The building process is the main focus of this lecture series. The process is understood as a sequence of criteria in time. |
| Objective     | Alongside a discussion of the basic principles, trends and terminologies, a closer look will be taken at each topic using case studies that investigate current structures as well as those relevant in terms of architecture and urban design. Active participation as well as interdisciplinary and process-oriented thinking on the part of students is a prerequisite. |
| Content       | The building process is the main focus of this lecture series. The process is understood as a sequence of criteria in time. These criteria are divided into acquisition and building legislation, building economics and facility management, the people involved and their work, construction and planning organization. Process thinking and a glance at our foreign neighbours complete the series. |
| Literature    | Literatureempfehlungen unter www.bauprozess.arch.ethz.ch. |
| 066-0411-00L  | Structural Design I                | W    | 2 credits | 2V    | P. Block, J. Schwartz |
| Abstract      | The course is an introduction to structural design using graphical methods and structural models, with a focus on a creative approach rather than repetitive calculations. Cable and membrane structures, arch and shell structures and combined arch and cable systems will be used to demonstrate these methods. |
| Objective     | The objective is to encourage students to develop an intuitive understanding of the relationship between the shape of a structure, the load it needs to carry and the forces in it. |
| Content       | To achieve this, the teaching is based on graphic statics, which allow the visualization of internal and external forces in structural systems, therefore illustrating the relationship between shape (form) and stress (force) in load bearing elements. This understanding is directly applied to the students' design projects, in which issues of statics and design overlap. |
| Literature    | Literature
"Faustformel Tragwerksentwurf"  
(Philippe Block, Christoph Gengangel, Stefan Peters,  
DVA Deutsche Verlags-Anstalt 2013, ISBN: 978-3-421-03904-0)  
Weiteres Lernmaterial:  
"Form and Forces: Designing Efficient, Expressive Structures"  
All concepts, approaches and methods will be introduced in the weekly lectures and practiced in subsequent exercises. |
| 151-1633-00L  | Energy Conversion                  | W    | 4 credits | 3G    | H. G. Park            |
| Abstract      | Fundamentals of Thermal Sciences in association with Energy Conversion |
| Objective     | To become acquainted and familiarized with basic principles of fundamental thermal sciences (Thermodynamics, Heat Transfer, etc.) as well as their linkage to energy conversion technologies. |
| Content       | Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications |
| Lecture notes | Slides will be distributed by e-mail every week. |
| Literature    | Literature
1. Introduction to Thermodynamics and Heat Transfer, 2nd ed. by Cengel, Y. A., McGraw Hill;  
2. Fundamentals of Engineering Thermodynamics, 6th ed. by Moran & Shapiro, Wiley |
| Prerequisites / notice | This course is intended for students outside of D-MAVT. |
| 401-0203-00L  | Mathematics                        | W    | 4 credits | 2V+1U | C. Busch             |
| Abstract      | This course gives an introduction to the following subjects: linear algebra (systems of linear equations, matrices), calculus, multivariable calculus, differential equations. |
| Objective     | Basic mathematical knowledge for engineers. Mathematics as a tool to solve engineering problems. |
| Content       | This course gives an introduction to the following subjects: linear algebra (systems of linear equations, matrices), calculus, multivariable calculus, differential equations. |
| Literature    | Tom M. Apostol, Calculus, Volume 1, One-Variable Calculus with an Introduction to Linear Algebra, 2nd Edition, Wiley  
Tom M. Apostol, Multi-Variable Calculus and Linear Algebra with Applications, 2nd Edition, Wiley |
Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>066-0413-00L</td>
<td>Materials and Constructions</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>M. Koebel</td>
</tr>
<tr>
<td>066-0415-00L</td>
<td>Building Physics: Theory and Applications</td>
<td>W</td>
<td>4</td>
<td>3G+1U</td>
<td>J. Carmeliet, D. Derome, K. Orehounig</td>
</tr>
<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Wokaun, A. Steinfeld</td>
</tr>
</tbody>
</table>

Abstract
Sustainable building construction, high performance materials for energy efficient buildings, focus on next generation building materials, sustainable construction, glazing, energy integration, production processes

Objective
The students will acquire knowledge in the following fields:
- Fundamentals of heat transport in (porous) materials
- Super-insulating materials and systems (including insulating nano-materials)
- Materials for retrofitting of buildings
- Introduction to durability problems of building facades
- Glazing, windows and glazed facades
- Materials for photovoltaic devices and solar thermal collector technology and their integration into buildings
- Materials for energy storage (thermal, electrical) and for decentralized energy generation
- Embodied energy of building materials. Introduction to LCA analysis for building materials
- Integrated building envelope solutions, multi-functional and adaptive facades, smart façade concepts

Literature

Abstract
Principles of heat and mass transport, hygro-thermal performance, durability of the building envelope and interaction with indoor and outdoor climates, applications.

Objective
The students will acquire knowledge in the following fields:
- Indoor and outdoor climate and driving forces.
- Hygrothermal properties of building materials.
- Building envelope solutions and their construction.
- Hygrothermal performance and durability.

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed during the course.

Literature

Prerequisites / notice
Fundamentals of chemistry and physics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

Abstract
This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.

Objective
This course intends to enable all students to:
- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation
This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success is small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

### Literature

Readings will be available on the TIMGROUP website.

### Prerequisites / Notice

No specific background in economics or management is required.

### 363-0503-00L Principles of Microeconomics

**Abstract**

The course introduces basic principles, problems and approaches of microeconomics.

**Objective**

The course includes the following main topics:

- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

**Lecture notes**

Lecture notes, exercises and reference material can be downloaded from Moodle.

**Literature**


The book can also be used for the course ‘Principles of Macroeconomics’ (Sturm)

For students taking only the course ‘Principles of Microeconomics’ there is a shorter version of the same book:


Complementary:


### 051-0515-15L Building Physics IV: Urban Physics

**Abstract**

Urban physics: wind, wind comfort, pollutant dispersion, natural ventilation, driving rain, heat islands, climate change and weather conditions, urban acoustics and energy use in the urban context.

**Objective**

- Basic knowledge of the global climate and the local microclimate around buildings
- Impact of urban environment on wind, ventilation, rain, pollutants, acoustics and energy, and their relation to comfort, durability, air quality and energy demand
- Application of urban physics concepts in urban design

**Content**

- Climate Change. The Global Picture: global energy balance, global climate models, the IPCC process. Towards regional climate scenarios: role of spatial resolution, overview of approaches, hydrostatic RCMs, cloud-resolving RCMs
- Urban micro climate and comfort: urban heat island effect, wind flow and radiation in the built environment, convective heat transport modelling, heat balance and ventilation of urban spaces - impact of morphology, outdoor wind comfort, outdoor thermal comfort, urban energy and urban design. Energy performance of building quarters and cities, decentralized urban energy production and storage technologies, district heating networks, optimization of energy consumption at district level, effect of the micro climate, urban heat islands, and climate change on the energy performance of buildings and building blocks.
- Wind driving rain (WDR): WDR phenomena, WDR experimental and modeling, wind blocking effect, applications and moisture durability
- Pollutant dispersion. pollutant cycle : emission, transport and deposition, air quality
- Urban acoustics. noise propagation through the urban environment, meteorological effects, urban acoustic modeling, noise reduction measures, urban vegetation

**Lecture notes**

All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

**Literature**

All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

**Prerequisites / Notice**

No prior knowledge is required.

### 066-0423-00L Application of CFD in Buildings

The number of participants is limited and enrolment is only possible in agreement with the chair.

**Abstract**

Fundamentals, Applications and Project works in the area of CFD in buildings.

**Objective**

Understanding:
- Basic principles of fluid flow & heat transfer
- Basic concepts of CFD
- Validation and verification, practical guidelines

Application and project works of CFD in buildings including the fields of:
- Building aerodynamics
- Steady vs. unsteady wind loads on urban structures
- Air pollution and contaminant dispersion
- Indoor ventilation
- CFD for renewable energy in the urban physics: Wind loads on roof-mounted solar photovoltaic arrays, coupled solar-wind energy generation applications, etc.
Content

I. Fundamentals
- Basic principles of fluid flow & heat transfer
- Laminar versus turbulent flow
- Forced vs. natural convection
- Basic concepts of CFD
- Discretization, stability & convergence, space and time-marching schemes, etc.
- Turbulence modelling
- Near-wall treatment
- Validation and verification, practical guidelines

II. Applications
CFD for:
- Building aerodynamics
- Steady vs. unsteady wind loads on urban structures
- Air pollution and contaminant dispersion
- Indoor ventilation
- CFD for renewable energy in the urban physics: Wind loads on roof-mounted solar photovoltaic arrays, coupled solar-wind energy generation applications, etc.

III. Project work
- Geometry and grid generation (from CAD to domain meshing)
- Exp. wind engineering
- Boundary conditions, solver settings and solution
- Data Post-processing
- Validation and error estimation
- Hands-on-Training
- Presentation

Specialised Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0235-00L</td>
<td>Thermodynamics of Novel Energy Conversion Technologies</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>D. Poulikakos</td>
</tr>
</tbody>
</table>

Abstract
In the framework of this course we will look at a broad spectrum of novel energy conversion processes which are not based on the heat-power-conversion. Especially the production of electrical energy without using mechanical work will be covered.

Objective
This course deals with novel energy conversion and storage systems such as fuel cells and micro-fuel cells, batteries, hydrogen production and storage, plasmonics and photovoltaics. The focus of the course is on the physics and basic understanding of those systems as well as their real-world applications.

Content
Part 1: Fundamentals:
- Thermodynamic overview and exergy analysis;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
- Electrochemistry;

Part 2: Novel energy conversion and storage systems:
- batteries and accumulators;
- fuel cells and micro fuel cells (fundamentals, fabrication, modelling, and applications);
- hydrogen production and storage, Fuel reforming;
- Plasmonics and photovoltaics.

Lecture notes available (ca. 200 pages in English)

Prerequisites / notice
The course will be given in English:
1. Weekly exercises, each includes 1 or 2 questions which should be solved and returned at the specified due dates. Exercises count as 15% of the final grade.
2. One programming mini-project which should be finished at the specified due date. It counts as 5% of the final grade.
3. Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.

151-0113-00L  | Applied Fluid Dynamics                              | W    | 4 credits | 2V+1U | J.P. Kunsch        |

Abstract
The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.

Objective
Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.

Content
Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water.

There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed.

The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fireballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.).

Lecture notes not available
Prerequisites / notice
Requirements: successful attendance at lectures "Fluidodynamik I und II", "Thermodynamik I und II"

151-0185-00L  | Radiation Heat Transfer                             | W    | 4 credits | 2V+1U | A. Steinfeld, A. Z’Graggen |

Abstract
Advanced course in radiation heat transfer

Objective
Fundamentals of radiative heat transfer for high-temperature applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.
R. Zenklusen
Fundamentals of acoustics, measuring and analyzing of acoustical events, anatomy and properties of the ear. Outdoor sound propagation.

An Introduction to Sustainable Development in the Built Environment
This course was offered as "Sustainable Construction" until HS14.

Content


Lecture notes
Copy of the slides presented.

Literature

151-0103-00L Fluid Dynamics II W 3 credits 2V+1U P. Jenny
Abstract

Objective
Expand basic knowledge of fluid dynamics. Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Content

Lecture notes
Lecture notes are available (in German). (See also info on literature below.)

Literature
Relevant chapters (corresponding to lecture notes) from the textbook

Prerequisites / notice
Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

401-0647-00L Introduction to Mathematical Optimization O 5 credits 2V+1U R. Zenklusen
Abstract
Introduction to basic techniques and problems of mathematical optimization.

Objective
The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

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

Literature
Information about relevant literature will be given in the lecture.

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

227-0477-00L Acoustics I W 6 credits 4G K. Heutschi
Abstract
Introduction to the fundamentals of acoustics in the area of sound field calculations, measurement of acoustical events, outdoor sound propagation and room acoustics of large and small enclosures.

Objective
Introduction to acoustics. Understanding of basic acoustical mechanisms. Survey of the technical literature. Illustration of measurement techniques in the laboratory.

Content
Fundamentals of acoustics, measuring and analyzing of acoustical events, anatomy and properties of the ear. Outdoor sound propagation, absorption and transmission of sound, room acoustics of large and small enclosures, architectural acoustics, noise and noise control, calculation of sound fields.

Lecture notes
yes

101-0579-00L Infrastructure Maintenance Processes W 3 credits 2G B. T. Adey
Abstract
This course provides an introduction to:
- how to model the changes in infrastructure objects over time,
- how to monitor these changes and assess the benefits of monitoring,
- how to intervene to improve infrastructure performance and assess the benefits of interventions, and
- how to model the changes in stakeholders interests over time.

Objective
Content
Deterioration
- manifest and latent processes,
- modeling
Monitoring
- non-destructive and destructive techniques,
- evaluation of benefits of monitoring
Intervention
- types of intervention,
- evaluation of benefits of intervention
Benefits
- modeling of stakeholder benefits over time

Lecture notes
All necessary materials (e.g. transparencies and hand-outs) will be handed out at the beginning of each class.

Literature
Appropriate reading material will be assigned when necessary.

101-0577-00L An Introduction to Sustainable Development in the Built Environment W 3 credits 2G G. Habert
Abstract
This year the UN Conference in Paris will shape future world objectives to tackle climate change.

This course provides an introduction to the notion of sustainable development when applied to our built environment.
Transport Planning Methods
3 credits
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by
The first hour of class is an interactive student presentation with discussion and class participation; each student is expected to present
Advanced Life Cycle Assessment (HS15)
The slides of the lecture are provided electronically.
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.
Everyone is expected to read one or two scientific articles or manuscripts each week, to be provided by the instructor.
1S
To improve ones understanding of life cycle assessment, and the broader issues in modeling, improving, and understanding sustainability
The course introduces the basic theories and methods of transport planning.
2R
The following topics give an overview of the themes that are to be worked on during the lecture.
- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development
Lecture notes
All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.
Literature
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.
102-1227-15L
Advanced Life Cycle Assessment (HS15) ■ W 1 credit 1S C. L. Mutel
Abstract
A seminar on current topic in life cycle assessment. In the fall of 2015, the focus is on assessment of complex systems. We will look a
number of topics, including input/output tables, optimization, and linking LCA with physical or economic models.
Objective
To improve ones understanding of life cycle assessment, and the broader issues in modeling, improving, and understanding sustainability
assessments.
Content
The first hour of class is an interactive student presentation with discussion and class participation; each student is expected to present
once, either alone or with one other student. The second half of class is devoted to a practical exercise of the concepts introduced and
examined in the first half.
Literature
Everyone is expected to read one or two scientific articles or manuscripts each week, to be provided by the instructor.
Prerequisites / notice
Students should be familiar with either life cycle assessment, environmental science, or economic modeling. This seminar is intended to be
primarily for Ph.D. students.
101-0417-00L
Transport Planning Methods W 6 credits 4G K. W. Axhausen
Abstract
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by
dividing the forecasting problem into sub-problems. The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.
Objective
- Knowledge of methods and algorithms commonly used in transport planning
- Understanding of algorithms and their implementations commonly used in transport planning
Content
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such
planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of
effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.
To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative
proportional fitting, shortest path algorithms and the method of successive averages.
The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own
models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely
guided and particularly suitable for students with little programming experience.
Lecture notes
The slides of the lecture are provided electronically.
Literature
101-0414-AAL
Transport Planning (Transportation I) W 3 credits 2R K. W. Axhausen
Enrolment only for MSc students who need this course as additional admission requirement.
Abstract
The lecture course discusses the basic concepts, approaches and methods of transport planning in both their theoretical and practical contexts.
Objective
The course introduces the basic theories and methods of transport planning.
Content
Basic theoretical links between transport, space and economic development; basic terminology; measurement and observation of travel
behaviour; methods of the four stage approach; cost-benefit analysis.
Literature
### Corporate Sustainability

**Abstract**

We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and offer e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a group project, focusing on one of the four sustainability challenges of Water, Energy, Mobility, and Food.

**Objective**

Understand the limits and the potential of corporate sustainability for sustainable development

Develop critical thinking skills that are useful for corporate sustainability (argumentation, communication, evaluative judgment)

**Content**

Be able to recognize and realize opportunities for corporate sustainability in a business environment

Overview of the grand sustainability challenges of Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for corporate strategy, marketing & leadership, technology & innovation, and financial markets.

Critical thinking skills for corporate sustainability

In-depth case study of concrete corporate sustainability challenge in the group project phase, such as: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze radical innovations for sustainability? How to invest money in a sustainable way?

**Lecture notes**

Presentation slides will be distributed prior to lectures.

**Literature**

Appropriate reading material (e.g., chapters out of certain textbooks or trade articles) will be assigned when necessary and made available via Moodle.

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### Introduction to Computational Physics (for Civil Engineers)

**Abstract**

This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell’s equation), Monte Carlo simulations, percolation, phase transitions.

**Content**


**Prerequisites / notice**

Lecture and exercise lessons in English

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### Digital Urban Simulation

**Abstract**

In this teaching unit architectural and urban design are analyzed by current computational methods. Based on these analyses the effects of plannings can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of these correspondent methods in early planning phases.

**Objective**

The students learn how the design and planning of cities can be evidence based by using scientific methods. The teaching unit convey knowledge in state-of-the-art and emerging spatial analysis and simulation methods and equip students with skills in modern software systems. The course consists of lectures, associated exercises and workshops, as well as of one integral project work.

**Content**

In a series of theory lectures we explore how the design and planning of cities can be evidence based by using scientific methods. By various exercises the students are equipped with skills in modern software systems. In an integral project work knowledge in state-of-the-art and emerging spatial analysis and simulation methods is deepened. Based on the imparted methods the effects of planning and design interventions can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of the correspondent computational methods in early planning phases.

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### Project Management: Pre-tender to Contract Execution

**Abstract**

This course will provide a comprehensive overview and understanding of the techniques, processes, tools and terminology to manage the Project Triangle (time, cost, quality) and to organize, analyze, control and report a complex project from Pre-Tender stage to Contract signature and Notice to Proceed. This is part 1 of a 3 part course, see notice below.

**Objective**

Upon successful completion of this course students will have the understanding of the Project Management duties and responsibilities from the Pre-Tender stage of a project to Contract Execution.

**Content**

- Project scope definition and project organization
- Technical specification proposals
- Work Breakdown Structure
- Estimating
- Schedule development
- Interface management
- Resource and cost integration
- Risk and opportunity identification and quantification
- Contract review and analysis
- Project life cycle
- Contract Execution - Project Manager Check List

**Lecture notes**

The slides will either be distributed at the beginning of the class, or made available online (via Moodle) prior to class. A copy of the appropriate chapter of the script, the assignment and any other assigned reading materials will be available via Moodle.

**Literature**

Appropriate reading material (e.g., chapters out of certain textbooks or trade articles) will be assigned when necessary and made available via Moodle.
We examine patterns of crowd-flows in an extraordinary urbanisation phenomena: festivals.

The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will

Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro- codes usually provide a framework that guarantees safety and reliability.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FORM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented. Bayesian networks are introduced as a generic numerical tool for solving such problems. The course also includes a tutorial using a software dedicated to real world structural reliability analysis.

The course covers concepts, methods and techniques in design, simulation and communication of cities. The goal is to learn principles and preconditions for the design of sustainable and smart cities.

Students gain insight into the next generation of design processes for architects and urban designers, and into concepts of the Information Architecture of SMART CITIES, including the influence of Big Data. They learn about the expanded roles of information and of architecture: information and simulation in architecture as means to make the invisible visible, and architecture as a metaphor and ordering system to structure the immense amounts of data of the Information Society. The seminar is highly interactive and discusses visionary case studies in Europe and Asia and new techniques in Big Data informed smart urban design. Apart from learning about and experiencing Information Architecture and SMART CITIES, the course also introduces research and management skills that will distinguish the future ETH architect. An iBook and the edX Massive Open Online Course (MOOC) Future Cities support the course.

SMART CITIES - What will happen when cities change from static configurations into responsive and dynamic structures? What does it mean for buildings that undergo the same changes? What is the impact on architectural and urban design education? How can citizens influence this development? The SMART CITIES course will answer these questions and supply you with the necessary skills and knowledge to understand and design such dynamic structures. The intelligent use of data and information are at the core of this course. Data and information are new building materials of future cities. Citizens produce increasing amounts of data in their daily life, with stationary sensors and mobile smartphones. Using those data, citizens begin to influence the design of future cities and the re-design of existing ones. The course will be a first step towards the emerging citizen design science and cognitive design computing. Those will be the next generation of participatory design and design computing.

The necessary texts will be found on the Chair's website at: http://www.ia.arch.ethz.ch. We specifically recommend the consultation of the Future Cities Website at: http://www.futurecities.ethz.ch during the entire course. The iBook INFORMATION CITIES is available in the iBooks Store for free.

The students will be randomly assigned to teams of 3 max. Students will be graded as a team based on the Project Proposal report and the in-class oral presentation of the Project Proposal. The Project Proposal will consist of an accumulation of the homework assignments.

For deepening the learnt in a semester thesis we offer to optimise the created simulations to make them available in interactive planning workshops. Additionally they could be converted into interactive web apps.

The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

Architecture and SMART CITIES, the course also introduces research and management skills that will distinguish the future ETH architect. An iBook and the edX Massive Open Online Course (MOOC) Future Cities support the course.

An iBook and the edX Massive Open Online Course (MOOC) Future Cities support the course.

The necessary texts will be found on the Chair's website at: http://www.ia.arch.ethz.ch. We specifically recommend the consultation of the Future Cities Website at: http://www.futurecities.ethz.ch during the entire course. The iBook INFORMATION CITIES is available in the iBooks Store for free.
The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.

The semester project is designed to train students in solving specific research questions in the field of integrated building systems. The semester project focuses in solving specific research questions in the field of integrated building systems. The goal is to apply acquired knowledge which is gained throughout the first year of the master's program. The semester project is advised by a professor who is affiliated with one of the partner departments of the Master program "Integrated building systems".

The purpose of this course is to understand and generate the flow of forces through a structural system in relation to its form, and to dimension its components. Using graphical methods, students are taught to understand and generate the flow of forces through a structural system in relation to its form, and to dimension its components. Awareness of the most important structural systems, understanding of the interplay of load and form. Estimation of the inner forces and dimensioning of elements.

The integrated design studio enables students to identify site specific energy demand and potentials, develop integrated energy and climate systems on both the urban and building scale and evaluate their interactions and impact on building design and operation. Retrieving relevant concepts and technologies of energy and HVAC systems, students are able to develop and compare integrated concepts using appropriate methods and digital toolsets and present them to a mixed audience using drawings, renderings and reports.

Students must have successfully passed the first year of MBS studies.

<table>
<thead>
<tr>
<th>Project courses</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>066-0425-00L</td>
<td>Integrated Design MBS</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>A. Schlüter</td>
</tr>
<tr>
<td>066-0431-00L</td>
<td>Semester Project MBS</td>
<td>O</td>
<td>6</td>
<td>13A</td>
<td>Lecturers</td>
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<tr>
<th>Semester Project</th>
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<tr>
<th>Compulsory Electives in Humanities, Social and Political Sciences</th>
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<tbody>
<tr>
<td>Recommended GESS compulsory elective courses (Type B) for D-ARCH.</td>
</tr>
<tr>
<td>see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability</td>
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<tr>
<td>see GESS Compulsory Electives: Language Courses ETH/UZH</td>
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<tr>
<th>Course Units for Additional Admission Requirements</th>
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<td>The courses below are only available for MSc students with additional admission requirements.</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>051-0412-AAL</td>
<td>Structural Design I / Structural Design II</td>
<td>E-</td>
<td>8</td>
<td>17R</td>
<td>P. Block, J. Schwartz</td>
</tr>
</tbody>
</table>

| Abstract | Structural Design I: Introduction to the design of structures, by means of graphic statics and structural models, focusing on cable, membrane, as well as arched and shell structures. Structural Design II: Determination of internal forces and description of structural behavior of mixed arches and cable structures, of truss systems, beams, slabs and frames using method of graphical statics. |
| Objective | Structural Design I: Using graphical methods, students are taught to understand and generate the flow of forces through a structural system in relation to its form, and to dimension its components. Structural Design II: Awareness of the most important structural systems, understanding of the interplay of load and form. Estimation of the inner forces and dimensioning of elements.
Structural Design I:
The students learn to determine the internal forces and understand the structural behavior of cable, arch, and combined arch-cable structures, but are also introduced to three-dimensional membrane and shell structures. By means of graphical design methods, such as graphic statics, students are taught to analyse the flow of forces through structural systems in relation to their form and to dimension the components of the systems.

Structural Design II:
Determination of internal forces and description of structural behaviour of mixed arches and cable structures, of truss systems, beams, slabs, panels and frames using method of graphical statics as well as dimensioning of these structural systems. Structural behaviour of columns. Discussion of reference buildings and illustration of interplay of structural system and architectural intention.

Lecture notes on eQuilibrium
http://www.block.arch.ethz.ch/equilibrium
and
http://www.schwartz.arch.ethz.ch/

"Faustformel Tragwerkentwurf"
(Philippe Block, Christoph Gengangel, Stefan Peters, DVA Deutsche Verlags-Anstalt 2013, ISBN: 978-3-421-03904-0)

Weiteres Lernmaterial:
"Form and Forces: Designing Efficient, Expressive Structures"

**151-1633-AAL Energy Conversion**

*Enrolment only for MSc students who need this course as additional admission requirement.*

**Abstract**
Fundamentals of Thermal Sciences in association with Energy Conversion

**Objective**
To become acquainted and familiarized with basic principles of fundamental thermal sciences (Thermodynamics, Heat Transfer, etc.) as well as their linkage to energy conversion technologies.

**Content**
- Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications
- Slides will be distributed by e-mail every week.

**Literature**
1. Introduction to Thermodynamics and Heat Transfer, 2nd ed. by Cengel, Y. A., McGraw Hill;
2. Fundamentals of Engineering Thermodynamics, 6th ed. by Moran & Shapiro, Wiley

This course is intended for students outside of D-MAVT.

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**Integrated Building Systems Master - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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</table>

**Prerequisites / notice**
This course is intended for students outside of D-MAVT.

**Key for Hours**

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Introduction to the theory of vector spaces for mathematicians and physicists including solutions of linear equations, linear transformations, and eigenvalues.

Objective: The ability to work with the basics of calculus in a mathematically rigorous way.


Literature: K. Koenigsberger: Analysis I, Springer-Verlag

R. Courant: Introduction to Calculus and Analysis, Springer Verlag

V. Zorich: Mathematical Analysis I. Springer Verlag 2009


H. Heuser: Lehrbuch der Analysis. Teubner Verlag

W. Walter: Analysis 1. Springer Verlag

O. Forster: Analysis I. Vieweg Verlag

J.Appell: Analysis in Beispielen und Gegenbeispielen. Springer Verlag

http://www.springerlink.com/content/q67803/?p=091fa376aade4cb8b2b2145fe2cee40&pi=4

Linear Algebra I

Introduction to the theory of vector spaces for mathematicians and physicists including solutions of linear equations, linear transformations, determinants, eigenvalues and eigenvectors, bilinear forms, canonical forms for matrices, and selected applications, part I.

Mastering basic concepts of Linear Algebra

Physics I

This course gives a first introduction to Physics. It emphasizes classical mechanics, together with an introduction to thermodynamics. The ability to work with the basics of calculus in a mathematically rigorous way.

Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.

General Chemistry (Physical Chemistry) I

Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.

Introduction to Physical Chemistry

Objective: The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Electives

General Chemistry (Inorganic Chemistry) I

Objective: Compulsory: online enrolment latest one week prior start of the semester

Content: The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes: http://www.gruetzmacher.ethz.ch/education/labcourses

Prerequisites / notice: Compulsory: online enrolment latest one week prior start of the semester

Additional First Year Compulsory Subjects

Practical Course General Chemistry

Objective: Information about the practical course will be given on the first day.

Abstract: Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration) analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Objective: Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements), metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration) analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

Content: The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes: http://www.gruetzmacher.ethz.ch/education/labcourses

Prerequisites / notice: Compulsory: online enrolment latest one week prior start of the semester

Electives

General Chemistry (Inorganic Chemistry) I

Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung.

Literature: V. Zorich: Mathematical Analysis I. Springer Verlag 2009


H. Heuser: Lehrbuch der Analysis. Teubner Verlag

W. Walter: Analysis 1. Springer Verlag

O. Forster: Analysis I. Vieweg Verlag

J.Appell: Analysis in Beispielen und Gegenbeispielen. Springer Verlag

http://www.springerlink.com/content/q67803/?p=091fa376aade4cb8b2b2145fe2cee40&pi=4

J. Appell: Analysis in Beispielen und Gegenbeispielen. Springer Verlag

http://www.math.ethz.ch/~blatter/

H. Heuser: Lehrbuch der Analysis. Teubner Verlag

W. Walter: Analysis 1. Springer Verlag

O. Forster: Analysis I. Vieweg Verlag

J.Appell: Analysis in Beispielen und Gegenbeispielen. Springer Verlag

http://www.springerlink.com/content/q67803/?p=091fa376aade4cb8b2b2145fe2cee40&pi=4

J. Appell: Analysis in Beispielen und Gegenbeispielen. Springer Verlag

http://www.springerlink.com/content/q67803/?p=091fa376aade4cb8b2b2145fe2cee40&pi=4


Prerequisites: Voraussetzungen:
- Mathematik I und II
- Allgemeine Chemie I und II
- Physikalische Chemie I


ECTS: 4 credits

3 credits

4 V+2 U

Molekulare Thermodynamik und Kinetik, Teil 1, Chemische Reaktionskinetik, Quack, M. und Jans-Bürli, S. 1986, VdF, Zürich. (Neuausgabe in Vorbereitung, wird verteilt.)

Physics III

Abstract
A basic introduction to quantum and atomic physics, including basics of optics and quantum statistical physics. The course will focus on the relation of these topics to experimental methods and observations.

Objective
Evidence for Quantum Mechanics: atoms, photons, photo-electric effect, Rutherford scattering, Compton scattering, de-Broglie waves.

Content
Quantum mechanics: wavefunctions, operators, Schrodinger's equation, infinite and finite square well potentials, harmonic oscillator, hydrogen atoms, spin.

Atomic structure: Perturbation to basic structure, including Zeeman effect, spin-orbit coupling, many-electron atoms. X-ray spectra, optical selection rules, emission and absorption of radiation, including lasers.

Optics: Fermat's principle, lenses, imaging systems, diffraction, interference, relation between geometrical and wave descriptions, interferometers, spectrometers.

Statistical mechanics: probability distributions, micro and macrostates, Boltzmann distribution, ensembles, equipartition theorem, blackbody spectrum, including Planck distribution.

Lecture notes: Lecture notes will be provided electronically during the course.

Literature


Statistical mechanics: "Statistical Physics", F. Mandl 0-471-91532-7

ECTS: 7 credits

4 V+2 U

B. Meyer

Data: 06.12.2018 13:04
Autumn Semester 2015
Objective
Many people can write programs. The "Introduction to Programming" course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas.

Content
Basics of object-oriented programming. Objects and classes. Pre- and postconditions, class invariants, Design by Contract. Fundamental control structures. Assignment and References. Basic hardware concepts. Fundamental data structures and algorithms. Recursion. Inheritance and deferred classes, introduction into event-driven design and concurrent programming. Basic concepts of Software Engineering such as the software process, specification and documentation, reuse and quality assurance.

Lecture notes
The lecture slides are available for download on the course page.

Literature
Bertrand Meyer: Touch of Class: Learning to Program Well Using Objects and Contracts, Springer Verlag, 2009; new printing, 2012. This is the official textbook for the course. See http://www.polybuchhandlung.ch/100/con_liste.asp

Prerequisites / notice
The course uses an "Outside-In" approach enabling students, right from the beginning, to use an advanced graphical library and produce significant applications. Students then learn step by step how the library is built, as a source of imitation and inspiration.

The course covers not only basic concepts of programming but also some advanced topics seldom encountered in introductory courses, such as recursion, undecidability, event-driven programming, multiple inheritance and others.

252-0847-00L Computer Science W 5 credits 2V+2U B. Gärtner

Abstract
This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

Objective
The goal of this lecture is an algorithmically oriented introduction to programming.

Content
This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

Lecture notes
Lecture notes in English and Handouts in German will be distributed electronically along with the course.

Literature

327-0103-00L Introduction to Materials Science W 3 credits 3G L. Heyderman, M. Niederberger, P. Uggowitzer

Abstract
Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.

Objective
Basic concepts in materials science.

Content
Contents:
Atomic structure
Crystalline structure, perfection - imperfection
Diffusion
Mechanical and thermal properties
Phase diagrams
Kinetics
Structural materials
Electric, magnetic and optical properties of materials
Materials selection criteria

Literature
James F. Shackelford
Introduction to Materials Science for Engineers

327-0301-00L Materials Science I W 3 credits 3G J. F. Löffler, A. R. Studart, P. Uggowitzer

Abstract
Basic concepts of metal physics, ceramics, polymers and their technology.

Objective
Based on the lecture 'Introduction to Materials Science' this lecture aims to give a detailed understanding of important aspects of materials science, with special emphasis on metallic and ceramic materials.

Content
Thermodynamics and phase diagrams, crystal interfaces and microstructure, diffusional transformations in solids, and diffusionless transformations will be presented for metallic alloys. The basics of the ionic and covalent chemical bonds, the bond energy, the crystalline structure, four important structural ceramics, and the properties of glasses and glass ceramics will be presented for ceramic materials.

Lecture notes
For metals see:
http://www.metamodel.mat.ethz.ch/education/courses/mat_wiss1/details
For ceramics see:
http://www.complex.mat.ethz.ch/education/lectures.html
Metals:
D. A. Porter, K. E. Easterling
Phase Transformations in Metals and Alloys - Second Edition
ISBN : 0-7487-5741-4
Nelson Thornes

Ceramics:
diverse CEN ISO Standards given in the slides
- Barsoum MW: Fundamentals of Ceramics:

- "Brevieral Ceramics" published by the "Verband der Keramischen Industrie e.V.", ISBN 3-924158-77-0. partly its contents may be found in the internet @ http://www.keramverband.de/brevier_engl/brevier.htm or on our homepage
- Silicon-Based Structural Ceramics (Ceramic Transactions), Stephen C. Danforth (Editor), Brian W. Sheldon, American Ceramic Society, 2003,
- Phase relationships in the zirconia-yttria system, HGM Scott - Journal of Materials Science, 1975, Springer
- In the first part of the lecture the bases are given for metals. In the second part the basics of ceramics will be presented.
- The lecture will be generally in German.

Prerequisites / notice

401-2303-00L Complex Analysis W 6 credits 3V+2U R. Pandharipande
Abstract Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, special functions, conformal mappings, Riemann mapping theorem.
Objective Working Knowledge with functions of one complex variables; in particular applications of the residue theorem
Literature Th. Gamelin: Complex Analysis. Springer 2001

401-2333-00L Methods of Mathematical Physics I W 6 credits 3V+2U G. Felder

402-0205-00L Quantum Mechanics I W 10 credits 3V+2U G. Blatter
Abstract Introduction to non-relativistic single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, Dirac-notation, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.
Objective Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, dimensionally symmetric problems in three dimensions, scattering theory, density matrices, Schrödinger-, Heisenberg-, Dirac-pictures, time reversal, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.
Lecture notes Deutsch

402-0255-00L Introduction to Solid State Physics W 10 credits 3V+2U K. Ensslin
Abstract The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, electronic properties of insulators, metals, semiconductors, transport properties, magnetism, superconductivity.
Objective Introduction to Solid State Physics.
Content The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, thermal properties of insulators; metals (classical and quantum mechanical description of electronic states, thermal and transport properties of metals); semiconductors (bandstructure and n/p-type doping); magnetism, superconductivity.
Lecture notes A Manuscript is distributed.
Literature Ibach & Lüth, Festkörperphysik
C. Kittel, Festkörperphysik
Ashcroft & Mermin, Festkörperphysik
W. Känzig, Kondensierte Materie

Data: 06.12.2018 13:04 Autumn Semester 2015 Page 792 of 1432
The course provides an overview of fundamental concepts and physical processes in astrophysics with the dual goals of: i) illustrating physical principles through a variety of astrophysical applications; and ii) providing an overview of research topics in astrophysics.

402-0595-00L Semiconductor Nanostructures

Abstract
The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.

Objective
At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:

1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots

Content
1. Introduction and overview
2. Semiconductor crystals: Fabrication and band structures
3. k.p-theory, effective mass
4. Envelope functions and effective mass approximation, heterostructures and band engineering
5. Fabrication of semiconductor nanostructures
6. Electrostatics and quantum mechanics of semiconductor nanostructures
7. Heterostructures and two-dimensional electron gases
8. Drude Transport
9. Electron transport in quantum point contacts; Landauer-Büttiker description
10. Ballistic transport experiments
11. Interference effects in Aharonov-Bohm rings
12. Electron in a magnetic field, Shubnikov-de Haas effect
13. Integer quantum Hall effect
14. Coulomb blockade and quantum dots

Lecture notes

Prerequisites / notice
The lecture is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program. The course is taught in English.

551-0015-00L Classical Mechanics

Abstract
A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

Objective
The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.

Content
Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch "Biology" (Campbell & Rees, 7th edition, 2005)
Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt

1. Aufbau der Zelle
Kapitel 5: Struktur und Funktion biologischer Makromoleküle
Kapitel 6: Eine Tour durch die Zelle
Kapitel 7: Membranstruktur und-funktion
Kapitel 8: Einführung in den Stoffwechsel
Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie
Kapitel 10: Photosynthese
Kapitel 12: Der Zellzyklus
Kapitel 17: Vom Gen zum Protein

2. Allgemeine Genetik
Kapitel 13: Meiose und Reproduktionszyklen
Kapitel 14: Mendel'sche Genetik
Kapitel 15: Die chromosomale Basis der Vererbung
Kapitel 16: Die molekulare Grundlage der Vererbung
Kapitel 18: Genetik von Bakterien und Viren
Kapitel 46: Tierische Reproduktion
Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik

Lecture notes
Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripten werden ggf. durch die Dozenten zur Verfügung gestellt.

Prerequisites / notice

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>3</td>
<td>G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
<td>Introduction into the most important spectroscopical methods and their applications to gain structural information. Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications. Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods. Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements. NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling. IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra. Raman spectroscopy. UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) and optical rotation dispersion (ORD). Atomic absorption, emission, and X-ray fluorescence spectroscopy: Basics, sample preparation. Script will be for the production price.</td>
</tr>
<tr>
<td>551-0105-00L</td>
<td>Fundamentals of Biology IA</td>
<td>5</td>
<td>G</td>
<td>M. Aebi, E. Hafen</td>
<td>Introduce to modern biology and to principal biological concepts. The course is divided into several chapters: 1. Basic principles of Evolution. 2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules. 3. The cell; structure; membrane structure and function, cell cycle. 4. Metabolism: Respiration; Photosynthesis; Fermentation. 5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution. Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 &quot;Instrumental analysis of organic compounds&quot; (4th semester) is recommended.</td>
</tr>
<tr>
<td>529-0221-00L</td>
<td>Organic Chemistry I</td>
<td>3</td>
<td>G</td>
<td>F. Diederich, C. Schaack</td>
<td>Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions. Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class. The topics covered range from different complexes. Dynamic phenomena (stereochemical nonrigidity). Complexes and kinetics. A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.</td>
</tr>
<tr>
<td>701-0245-00L</td>
<td>Introduction to Evolutionary Biology</td>
<td>2</td>
<td>V</td>
<td>G. Velicer, S. Wielgoss</td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for understanding a number of evolutionary problems in the basic and applied sciences.</td>
</tr>
</tbody>
</table>
Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

Textbook: Evolutionary Analysis
Scott Freeman and Jon Herron

The exam is based on lecture and textbook.

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Topics of the course.
- Physical properties of water (i.e. density and equation of state)
- Global water resources
- Exchange at boundaries
  - Energy (thermal & kinetic), gas exchange
  - Vertical stratification, large scale transport
  - Turbulence and mixing
  - Mixing and exchange processes in rivers
- Groundwater and its dynamics
  - Ground water as part of the terrestrial water cycle
  - Ground water hydraulics, Darcy's law
  - Aquifers and their properties
  - Hydrochemistry and tracer
- Ground water use

Case studies
- 1. Water as resource, 2. Water and climate

In addition to the suggested literature handouts are distributed.

Suggested literature.

The case studies and the analysis of the questions and problems are integral part of the course.

This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters.

This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

This lecture is an introduction to numerical methods in Environmental Sciences. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Five exercises are provided (CHF 10.- per copy). Example programs and graphics tools are supplied.

This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

The students are able to
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how mountains influence the atmospheric flow on different scales

Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes and slides

Lecture notes and slides

Lecture notes and slides

Lecture notes and slides

Lecture notes and slides
Introduction to the experimental methods of Inorganic Chemistry

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

Powerpoint slides and script will be made available.

Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kiecdahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), redoxreactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration)

We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is a additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

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

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

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

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


Prerequisites / notice

Prerequisites: Basic knowledge in chemistry, biology and geology.

Pedosphere

Lecture notes


- Rogers and Yau, A Short Course in Cloud Physics, Pergamon Press, 1989;

Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Elsevier, 2006

There is a additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

Microbiology

Lecture notes

W 2 credits 2V

M. Ackermann, M. Schuppler, J. Vorholt-Zambelli

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

Teaching of basic knowledge in microbiology.


Wird von den jeweiligen Dozenten ausgegeben.

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

Microbiology

Literature

Further Laboratory Courses arising upon specific written request by the students and permission by the Director of studies.

Laboratory Courses, Semester Papers, Proseminars, Field Trips

Future Laboratory Courses arising upon specific written request by the students and permission by the Director of studies.

Number Title Type ECTS Hours Lecturers

529-0011-04L Practical Course General Chemistry ■ O 8 credits 12P H. V. Schönberg, E. C. Meister

Information about the practical course will be given on the first day.

Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redoxreactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration)

Analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kiecdahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements), metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration)

Analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements, thermodynamics (calorimetry)

The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

http://www.gruetzmacher.ethz.ch/education/labcourses

529-0129-00L Inorganic and Organic Chemistry II W 11 credits 16P A. Mezzetti, A. Togni

Introduction to the experimental methods of Inorganic Chemistry

The teaching laboratory offers an insight into different aspects of Inorganic Chemistry, including solid state chemistry, organometallic chemistry, kinetics, etc.. The synthesis, characterization and analysis of inorganic compound are a main topic. Emphasis is given to scientific writing (experiment reports).

529-0011-04L

Prerequisites / notice

Compulsory: online enrolment latest one week prior start of the semester

529-0129-00L

Latest online enrolment is one week before the beginning of the semester.

529-0011-04L

Latest online enrolment is one week before the beginning of the semester.

529-0129-00L

Latest online enrolment is one week before the beginning of the semester.

529-0011-04L

Latest online enrolment is one week before the beginning of the semester.

529-0129-00L

Latest online enrolment is one week before the beginning of the semester.
Inorganic chemistry part: Synthesis and analysis of elemento-organic compounds, metal complexes, and organometallic compounds. Introduction to Schlenk techniques, solid state synthesis, and kinetics. Introduction in the chemistry library; literature data banks and collections of spectra.

Organic synthesis with organometallic compounds and catalysts: Experiments in the framework of a selected specialised project. Possible projects: Rh catalysed asymmetric hydrogenation of enamides, Mn-catalysed epoxidation of olefins, Cu catalysed Diels-Alder reactions, synthesis of organo-boron compounds and Pd catalysed coupling with halides, Ru catalysed transfer hydrogenation.

Laboratory Courses, Semester Papers, Proseminars, Field Trips

### 5. Semester

#### Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>529-0400-00L</td>
<td>Bachelor’s Thesis</td>
<td>O</td>
<td>15 credits</td>
<td>15D</td>
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<tr>
<td>551-0105-00L</td>
<td>Fundamentals of Biology IA</td>
<td>O</td>
<td>5 credits</td>
<td>5G</td>
<td>M. Aebi, E. Hafen</td>
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</tbody>
</table>

### Biochemical-Physical Direction

#### 1. Semester (Biochemical-Physical Direction)

#### Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-0271-00L</td>
<td>Mathematical Foundations I: Analysis A</td>
<td>W</td>
<td>5 credits</td>
<td>3V+2U</td>
<td>T. Bühler</td>
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<tr>
<td>401-1261-07L</td>
<td>Analysis I</td>
<td>W</td>
<td>10 credits</td>
<td>6V+3U</td>
<td>H. Knör rer</td>
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### Additional First Year Compulsory Subjects

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0011-04L</td>
<td><strong>Practical Course General Chemistry</strong></td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
</tbody>
</table>

Information about the practical course will be given on the first day.

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#### Literature
- K. Koenigsberger: Analysis I, Springer-Verlag
- R. Courant: Introduction to Calculus and Analysis, Springer-Verlag
- V. Zorich: Mathematical Analysis I, Springer Verlag 2009
- H. Heuser: Lehrbuch der Analysis, Teubner Verlag
- W. Walter: Analysis I. Springer Verlag
- O. Forster: Analysis I, Vieweg Verlag
- J. Appell: Analysis in Beispielen und Gegenbeispielen, Springer Verlag http://www.springerlink.com/content/pq7609/?p=091fa378ade4cbf82b2145fe2cee40&pi=4

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<tr>
<th>Code</th>
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<tbody>
<tr>
<td>529-0001-00L</td>
<td>Introduction to Computer Science</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>P. H. Hümenerberger</td>
</tr>
</tbody>
</table>

Introduction to UNIX, data representation, introduction to C++ programming, errors, algorithms, computer architecture, sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, software engineering.

For more information: www.csms.ethz.ch/education/infol

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<thead>
<tr>
<th>Code</th>
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<tr>
<td>529-0001-02L</td>
<td>General Chemistry (Inorganic Chemistry) I</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>A. Togni</td>
</tr>
</tbody>
</table>

Introduction to the chemistry of ionic equilibria: Acids and bases, redox reactions, formation of coordination complexes and precipitation reactions

For more information: www.csms.ethz.ch/education/infol

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<tr>
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<tbody>
<tr>
<td>529-0001-03L</td>
<td>General Chemistry (Organic Chemistry) I</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>H. Wennenbers</td>
</tr>
</tbody>
</table>

Introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions.

For more information: www.csms.ethz.ch/education/infol

<table>
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<tbody>
<tr>
<td>529-0001-01L</td>
<td>General Chemistry (Physical Chemistry) I</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>F. Merkt</td>
</tr>
</tbody>
</table>

Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.

For more information: www.csms.ethz.ch/education/infol

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### Additional First Year Compulsory Subjects

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>529-0011-04L</td>
<td><strong>Practical Course General Chemistry</strong></td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
</tbody>
</table>

Latest online enrolment is one week before the beginning of the semester.

Information about the practical course will be given on the first day.
Abstract
Qualitative analysis (determination of cations and anions, acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration), analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements, metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration), analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes
http://www.gruetzmacher.ethz.ch/education/labcourses

Prerequisites / notice
Compulsory: online enrolment latest one week prior start of the semester
### Content

1.) Klassifizierung von PDE's:
   - linear, quasilinear, nicht-linear
   - elliptisch, parabolisch, hyperbolisch

2.) Quasilineare PDE:
   - Methode der Charakteristiken (Beispiele)

3.) Elliptische PDE:
   - Bsp: Laplace-Gleichung
   - Harmonische Funktionen, Maximumsprinzip, Mittelwerts-Formel.
   - Methode der Variablenseparation.

4.) Parabolische PDE:
   - Bsp: Wärmeleitungsgleichung
   - Bsp: Inverse Wärmeleitungsgleichung
   - Methode der Variablenseparation

5.) Hyperbolische PDE:
   - Bsp: Wellengleichung
   - Formel von d'Alembert in (1+1)-Dimensionen
   - Methode der Variablenseparation

6.) Green'sche Funktionen
   - Rechnen mit der Dirac-Deltafunktion
   - Idee der Green'schen Funktionen (Beispiele)

7.) Ausblick auf numerische Methoden
   - 5-Punkt-Discretisierung des Laplace-Operators (Beispiele)

### Literature


Zusätzliche Literatur:
- Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, Kap. 8, 11, 16 (sehr gutes Buch, als Referenz zu benutzen)
- Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen", vdf Hochschulverlag AG an der ETH Zürich.
- G. Felder:Partielle Differenzialgleichungen.
- http://www.math.ethz.ch/u/felder/Teaching/PGD

### Prerequisites / notice

- Prerequisites: Analysis I and II, Fourier series (Komplexe Analyse)

### 402-0403-00L

**Physics I**

<table>
<thead>
<tr>
<th>Objective</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>听课了解科学本身的物理原理；解决物理问题的技能。</td>
<td></td>
</tr>
</tbody>
</table>

| Content |
| Mechanics (motion, Newton's laws, work and energy, conservation of momentum, reaction, gravitation, fluids) Periodic Motion and Waves (periodic motion, mechanical waves, acoustics). |

| Lecture notes |
| The lecture follows the book "Physics" by Paul A. Tipler. |

| Literature |
| Paul A. Tipler and Gene P. Mosca, Physics for Scientists and Engineers, W.H. Freeman (see also "Physik für Wissenschaftler und Ingenieure"); Springer Spektrum. |

### 529-0422-00L

**Physical Chemistry II: Introduction to Chemical Reaction Kinetics**

| Objective |
| Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems. |

| Content |

| Lecture notes |

| Literature |

### 529-0221-00L

**Organic Chemistry I**

| Objective |
| Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class. |

| Content |
| Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions. |

### Prerequisites / notice

- Prerequisites: Mathematics I & II
The goal of this lecture is an algorithmically oriented introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

### Literature

No set textbooks. Optional literature will be proposed at the beginning of the class and in the lecture notes.

### Electives

**Im Bachelor-Studienweg Interdisziplinäre Naturwissenschaften können die Studierenden prinzipiell alle Lehrveranstaltungen wählen, die in einem Bachelor-Studienweg der ETH angeboten werden.**


#### 529-0051-00L Analytical Chemistry I

**Abstract**
Introduction into the most important spectroscopical methods and their applications to gain structural information.

**Objective**
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications.

**Content**
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
- Mass spectrometry: Ionization effects, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.

**Lecture notes**
Script will be for the production price

**Literature**
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

**Prerequisites / notice**
Excercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

#### 529-0121-00L Inorganic Chemistry I

**Abstract**
Complexes of the transition metals: structure, bonding, spectroscopic properties, and synthesis.

**Objective**
Introduction to the binding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties.

**Content**
The chemical bond (overview). Symmetry and group theory. The chemical bond of coordination compounds (Valence Bond Theory, Crystal Field Theory, Molecular Orbital Theory (sigma- and pi-bonding); pi-Accepting ligands (CO, NO, olefins, dioxygen, dihydrogen, phosphines and phosphites). Electronic spectra of coordination compounds (Tanabe-Sugano diagrams). Coordination numbers and isomers in complexes. Dynamic phenomena (stereochemical nonrigidity). Complexes and kinetics.

**Lecture notes**
Can be bought at the HCI-shop

**Literature**

#### 252-0847-00L Computer Science

**Abstract**
This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

**Objective**
The goal of this lecture is an algorithmically oriented introduction to programming.

**Content**
This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

**Lecture notes**
Lecture notes in English and Handouts in German will be distributed electronically along with the course.

**Literature**
- Andrew Koenig and Barbara E. Moo: Accelerated C++, Addison-Wesley, 2000
Abstract
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content
Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- DNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networking
- Molecular dynamics simulation

401-0373-00L Mathematics III: Partial Differential Equations

Abstract

Objective
The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.

Content
## Examples of partial differential equations
- Classification of PDEs
- Superposition principle

## One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

## Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

## Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

## Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

Lecture notes
There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

Literature
2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press
3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)

Prerequisites / notice
It is required a minimal background of: 1) multivariables functions (Riemann integrals in two or three variables, change of variables in the integrals through the Jacobian, partial derivatives, differentiability, Jacobian) 2) numerical and functional sequences and series, basic knowledge of ordinary differential equations.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lectures</th>
<th>Tutorials</th>
<th>Instructor(s)</th>
</tr>
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<tbody>
<tr>
<td>401-2303-00L</td>
<td>Complex Analysis</td>
<td>W 6 credits</td>
<td>3V+2U</td>
<td>R. Pandharipande</td>
<td></td>
</tr>
<tr>
<td>402-2203-01L</td>
<td>Classical Mechanics</td>
<td>W 7 credits</td>
<td>4V+2U</td>
<td>C. Anastasiou</td>
<td></td>
</tr>
<tr>
<td>401-2333-00L</td>
<td>Methods of Mathematical Physics I</td>
<td>W 6 credits</td>
<td>3V+2U</td>
<td>G. Felder</td>
<td></td>
</tr>
<tr>
<td>402-2883-00L</td>
<td>Physics III</td>
<td>W 7 credits</td>
<td>4V+2U</td>
<td>A. Wallraff</td>
<td></td>
</tr>
<tr>
<td>402-0263-00L</td>
<td>Astrophyiscs I</td>
<td>W 10 credits</td>
<td>3V+2U</td>
<td>A. Refregier</td>
<td></td>
</tr>
<tr>
<td>752-4001-00L</td>
<td>Microbiology</td>
<td>W 2 credits</td>
<td>2V</td>
<td>M. Ackermann, M. Schuppler, J. Vorholt-Zambelli</td>
<td></td>
</tr>
<tr>
<td>701-0243-01L</td>
<td>Biology III: Essentials of Ecology</td>
<td>W 3 credits</td>
<td>2V</td>
<td>S. Güsewell, C. Vorburer</td>
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</table>

Abstract

Introduction to the theory of vector spaces for mathematicians and physicists including solutions of linear equations, linear transformations, determinants, eigenvalues and eigenvectors, bilinear forms, canonical forms for matrices, and selected applications, part I.

Objective

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

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

Literature
Generelle Ökologie:
Aquatische Ökologie:
Lampert & Sommer 1999. Limnökologie. Thieme, 2. Aufl., ca. Fr. 55.-;
Bohle 1995. Limnische Systeme. Springer, ca. Fr. 50.-
Naturschutzbiologie:

701-0245-00L Introduction to Evolutionary Biology

Abstract
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

Objective
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

Content
Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

Literature
Textbook:
Evolutionary Analysis
Scott Freeman and Jon Herron

Prerequisites / notice
The exam is based on lecture and textbook.

701-0023-00L Atmosphere

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Literature

701-0501-00L Pedosphere

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

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

Content
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical and chemical properties of soils, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Literature
- Lecture notes can be purchased during the first lecture (15.- SFr)
- Prerequisites: Basic knowledge in chemistry, biology and geology.

701-0401-00L Hydrosphere

Abstract
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Objective
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.
### Biochemistry

**W 2 credits 2V**  
H.P. Kohler

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

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

Students are able to describe the relevant metabolic reactions in detail.

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

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

**Prerequisites / notice**
The case studies and the analysis of the questions and problems are integral part of the course.

### Chemistry of Aquatic Systems

**W 3 credits 2G**  
L. Winkel

**Abstract**
This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

**Objective**
Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters. Evaluation of analytical data from aquatic systems.

**Content**
Introduction to the chemistry of aquatic systems. Regulation of the composition of natural waters by chemical, geochemical and biological processes. Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.

**Lecture notes**
Script is distributed.

**Literature**

### Numerical Methods in Environmental Sciences

**W 3 credits 2G**  
C. Schär, O. Fuhrer

**Abstract**
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Objective**
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Content**
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

**Lecture notes**
Is provided (CHF 10. per copy).

**Literature**
List of literature is provided.

**Prerequisites / notice**
Die Vorlesung verlangt Vorwissen in Linearer Algebra, Analysis und Physik (z.B. komplexe Zahlen, Beschreibung von ebenen Wellen, einfache gewöhnliche Differentialgleichungen)

### Introduction to Programming

**W 7 credits 4U+2V**  
B. Meyer

**Abstract**
Introduction to fundamental concepts of modern programming and operational skills for developing high-quality programs, including large programs as in industry. The course introduces software engineering principles with an object-oriented approach based on Design by Contract as present in Eiffel. For the second time we offer a supporting MOOC (online) version with more exercises and a hint system.

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**Data:** 06.12.2018 13:04  
**Autumn Semester 2015**  
**Page 805 of 1432**
Objective

Many people can write programs. The "Introduction to Programming" course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas.

Content

Basics of object-oriented programming. Objects and classes. Pre- and postconditions, class invariants. Design by Contract. Fundamental control structures. Assignment and References. Basic hardware concepts. Fundamental data structures and algorithms. Recursion. Inheritance and deferred classes, introduction into event-driven design and concurrent programming. Basic concepts of Software Engineering such as the software process, specification and documentation, reuse and quality assurance.

Lecture notes

Textbook: "Touch of Class" (see under "Literatur")

The lecture slides are available for download on the course page.

Literature

Bertrand Meyer: Touch of Class: Learning to Program Well Using Objects and Contracts, Springer Verlag, 2009; new printing, 2012. This is the official textbook for the course. See http://www.polybuchhandlung.ch/100/con_liste.asp

Prerequisites / notice

The course uses an "Outside-In" approach enabling students, right from the beginning, to use an advanced graphical library and produce significant applications. Students then learn step by step how the library is built, as a source of imitation and inspiration.

The course covers not only basic concepts of programming but also some advanced topics seldom encountered in introductory courses, such as recursion, undecidability, event-driven programming, multiple inheritance and others.

### 5. Semester (Biochemical-Physical Direction)

#### Laboratory Courses, Semester Papers, Proseminars, Field Trips

Laboratory Courses arising upon specific written request by the students and permission by the Director of studies.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0450-00L</td>
<td>Semester Project</td>
<td>W</td>
<td>18 credits</td>
<td>18A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Objective

Students are accustomed to scientific work and they get to know one specific research field.

#### Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0400-00L</td>
<td>Bachelor's Thesis</td>
<td>O</td>
<td>15 credits</td>
<td>15D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Objective

It completes the Bachelor program and consists of a scientific project carried out independently.

Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

#### Second and Third Year Additional Subjects

For the Bachelor in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Bachelor level at ETH Zurich.

At the beginning of the 2. year an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2010.

#### Other Electives ETH

Further combinations of Compulsory elective subjects arising upon specific written request by the students and permission by the Director of studies.

Course Catalogue of ETH

### Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-CHAB.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

### Interdisciplinary Sciences Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Interdisciplinary Sciences Master

For the Master in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Master level at ETH Zurich.

At the beginning of the Master studies an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2007.

▶ Majors

The students can choose from all Majors as provided by the following list: http://www.chab.ethz.ch/lehre/in_msc/index_EN

Furthermore it is also possible to create an individual Majors as specified in Art. 19 paragraph 3 of the Programme Regulations.

▶ General Courses

Selection of courses of ETH, according individual curriculum.

▶ Proseminars, Laboratory Courses, Research Projects and Sem. Papers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0020-00L</td>
<td>Research Project</td>
<td>W</td>
<td>20 credits</td>
<td>20A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

▶ Compulsory Electives in Humanities, Social and Political Sciences

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Recommended GESS compulsory elective courses (Type B) for D-CHAB.

▶ Master Thesis

If more than 20 credits are acquired by the Master Thesis, select a course of the ETH course catalog with similar content to the specific major of your study program. Registration by the study administration (HCI H201).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1000-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>20 credits</td>
<td>43D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1000-30L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

Interdisciplinary Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ECTS**
- European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Food Science Bachelor

### 1. Semester

#### First Year Examinations

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

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

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

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

**Lecture notes**
ca. 360 Seiten mit vielen Figuren und durchgerechneten Beispielen.

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

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

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

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

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

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

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

**Prerequisites / notice**
Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

**Assistance:**
Mondays 12-13, Tuesdays 17-19, Wednesdays 17-19, in Room HG E 41.

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0001-00L</td>
<td>General Biology I</td>
<td>O</td>
<td>3</td>
<td>3V</td>
<td>U. Sauer, A. Widmer</td>
</tr>
</tbody>
</table>

**Abstract**
Basics of structure, formation and function of cells and biomacromolecules, principles of metabolism, as well as basic classical and molecular genetics and evolutionary biology. First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.

**Objective**
The understanding of some basic principles of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its functions, as well as metabolism, inheritance and evolution.
The structure and function of biomacromolecules; basics of metabolism; cell biology; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, meiosis and sexual life cycles; Mendelian and molecular genetics; animal reproduction and behavior; sensory and motor mechanisms; population biology and evolution; principles of phylogeny.

The Campbell Chapters 1-4 (10th edition) under the heading “The role of chemistry in biology” are expected. We will treat the following Campbell chapters:

1. Biochemistry
2. Biological Macromolecules and Lipids
3. Cell biology
4. Cell Structure and Function
5. Cell biology
6. Cell Membranes
7. Cell biology
8. Cellular Respiration: An Introduction to Metabolism
9. Cell biology
10. Cellular Respiration
11. Cell biology
12. Photosynthesis

Lecture notes
- no script

Literature

Prerequisites / notice
- The lecture is the first in a series of two lectures given over two semesters for students with biology as a basic subject.

**Course: 701-0243-01L Biology III: Essentials of Ecology**

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

**Objective**
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community, and the ecosystem level. The students should learn ecological concepts at these different levels in the context of concrete examples from terrestrial and aquatic ecology. Corresponding methods for studying the systems will be presented.

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

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

**Prerequisites / notice**
- Further information:
  - https://moodle-app2.let.ethz.ch/course/info.php?id=1682

**Course: 701-0025-00L Earth and Natural Production Systems**

**Abstract**
The lecture provides a science-based exploration of key aspects of our planet: from its formation, to its properties and resources (minerals, soils, climate, water, vegetation), to agricultural production.

**Objective**
Overview and understanding of key aspects of planet earth and its role for agricultural production, including consideration of current challenges such as climate change, water crises, deforestation, north-south conflict and biodiversity.

**Content**
Origin of the planetary system, composition of the earth and the atmosphere, formation of continents and oceans, biogeochemical cycles, plate tectonics and earthquakes, erosion, climate, water cycle, surface waters, vegetation, forests and crops, food production including related worldwide ecological and economical interactions.

**Prerequisites / notice**
- Scripts provided by each teaching person.

Further information:
- https://moodle-app2.let.ethz.ch/course/info.php?id=1682

**Course: 701-0757-00L Principles of Economics**

**Abstract**
This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.

**Objective**
Students are able to
- describe fundamental micro- and macroeconomic issues and theories.
- apply suitable economic arguments to a given theme.
- evaluate economic measures.

**Content**
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomics policies

**Prerequisites / notice**
- available on electronic platform

Laboratory Course: Elementary Chemical Techniques

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

Objective

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

Literature


Prerequisites / notice
electronic platform

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-0013-00L</td>
<td>World Food System</td>
<td>O</td>
<td>4 credits</td>
<td>4V</td>
<td>N. Buchmann, M. Kreuzer, M. Loessner, D. Moretti, M. Sonneveld, E. J. Windhab</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>Knowledge about the World Food System will be provided, based on case studies along food value chains in countries with various development stages and dependent on multiple boundary conditions. This shall generate profound understanding of the associated global challenges especially food scarcity, suboptimal diet and nutrition, food quality and safety as well as effects on the environment.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td>Attending this course, the students will recognize the elements of the World Food System (WFS) approach and the problems it this supposed to treat. They will especially comprehend the four pillars of global food security, namely (I) food availability (including sustainable production and processing), (II) access to food (physical and monetary), (III) food use (including quality and safety as well as the impact on human health and well being) and (IV) resilience to the boundary conditions (environmental, economic and political). This insight will make them aware of the global driving forces behind our ETH research on food security and is expected to alleviate motivation and understanding for the association of subsequent specific courses within a general context. The course equivalently implements agricultural and food sciences, thus supporting the interdisciplinary view on the WFS scope.</td>
</tr>
<tr>
<td></td>
<td><strong>Content</strong></td>
<td></td>
<td></td>
<td></td>
<td>Case studies on certain foods of plant and animal origin serve to demonstrate the entire food value chain from the production of raw material to processed food and its consumer relevant property functions. In doing so, important corresponding aspects for developed, emerging and developing countries are demonstrated, by use of engineering as well as natural and social science approaches.</td>
</tr>
<tr>
<td></td>
<td><strong>Lecture notes / literature</strong></td>
<td></td>
<td></td>
<td></td>
<td>Handouts and links are provided online.</td>
</tr>
</tbody>
</table>

Additional First Year Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>L. E. Fässler, H.J. Böckenhauer, M. Dahinden, D. Komp</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: publishing over the internet, processing and visualizing time series, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to macro programming, universal methods for algorithm design.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td>The students learn to - choose and apply appropriate tools from computer science, - process and analyze real-world data from their subject of study, - handle the complexity of real-world data, - know universal methods for algorithm design.</td>
</tr>
<tr>
<td></td>
<td><strong>Lecture notes / literature</strong></td>
<td></td>
<td></td>
<td></td>
<td>Handsouts and links are provided online. All materials for the lecture are available at <a href="http://www.evim.ethz.ch">www.evim.ethz.ch</a>.</td>
</tr>
<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
<td></td>
<td></td>
<td></td>
<td>This course is based on application-oriented learning. The students spend most of their time working through electronic tutorials and discussing their results with teaching assistants.</td>
</tr>
<tr>
<td>751-0801-00L</td>
<td>Biology I: Laboratory Exercises</td>
<td>O</td>
<td>1 credit</td>
<td>2U</td>
<td>E. B. Truernit</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td>Capability of preparing biological specimen, microscopy and documentation. Understanding the correlation between plant structure and function at the level of organs, tissues and cells.</td>
</tr>
<tr>
<td></td>
<td><strong>Lecture notes / literature</strong></td>
<td></td>
<td></td>
<td></td>
<td>Handsouts and links are provided online. For further reading (not obligatory): Gerhard Wanner: Mikroskopisch- Botanisches Praktikum, Georg Thieme Verlag, Stuttgart.</td>
</tr>
<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
<td></td>
<td></td>
<td></td>
<td>Groups of a maximum of 30 students.</td>
</tr>
<tr>
<td>529-0030-00L</td>
<td>Laboratory Course: Elementary Chemical Techniques</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>N. Kobert, M. Morbidelli</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td>This course is intended to provide an overview of experimental chemical methods. The handling of chemicals and proper laboratory techniques represent the main learning targets. Furthermore, the description and recording of laboratory processes is an essential part of this course.</td>
</tr>
</tbody>
</table>
Content
The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:
Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvatation or precipitation processes) is studied.
Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

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

Literature
A thorough study of all script materials is requested before the course starts.

751-0001-00L Introduction to the Study Program E- 0 credits 1V Lecturers
Abstract
Technical and organizational guidance to Freshmen.
Objective
Support to Freshmen in Agricultural Science and Food Sciences
Content
Information on:
Program structure, regulations, bachelor thesis, project work, practice and the importance of first year basics.
Organization: department, institutes, professorships and research, students' associations.

3. Semester

Basic Courses II: Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
</tr>
<tr>
<td></td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Strahlenoptik, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomenene, Wärmestrahlung</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Skript wird verteilt.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Literature
Friedhelm Kuypers
Physik für Ingenieure und Naturwissenschaftler
Band 2 Elektrizität, Optik, Wellen
Verlag Wiley-VCH, 2003, Fr. 77.-
Douglas C. Giancoli
Physik
3. erweiterte Auflage
Pearson Studium
Hans J. Paus
Physik in Experimenten und Beispielen
Carl Hanser Verlag, München, 2002, 1068 S.
Paul A. Tipler
Physik
Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-
David Halliday Robert Resnick Jearl Walker
Physik
Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03)
dazu gratis Online Ressourcen (z.B. Simulationen): www.halliday.de

701-0071-00L Microbiology O 2 credits 2V M. Ackermann, M. Schuppler, J. Vorholt-Zambelli
Abstract
Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.
Objective
Teaching of basic knowledge in microbiology.
Content
Lecture notes
Wird von den jeweiligen Dozenten ausgegeben.
**701-0255-00L**

**Biochemistry**

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

**Objective**

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

Students are able to describe the relevant metabolic reactions in detail

**Content**

Program

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

**Lecture notes**

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

**Prerequisites / notice**

Basic knowledge in biology and chemistry is a precondition.

---

**701-0255-00L**

**Physiology and Anatomy I**

Imparts a basic understanding of physiology and anatomy in man, focusing on the interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. One major topic of the lecture is food intake and digestion with its correlated chemo-, endocrine and metabolic processes.

**Objective**

At the end of the course the students understand the basic functions of the organ systems and functionally important morphological features. One focus of the course is on aspects related to nutrition and overweight including the resulting diseases.

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**701-0225-00L**

**Organic Chemistry**

Introduction to Isomerism.
Reaction mechanisms in organic chemistry (substitutions, additions, eliminations condensations)
Biosynthesis of Terpenes.

**Objective**

The students are able to differentiate between structural and stereoisomers.
The students know the basic reaction mechanisms in organic chemistry. They are able to understand and formulate simple biochemical rections.
They know the basics of the biosynthesis of terpenes.

**Content**

Isomerism (structural isomers, stereoisomers).
Descriptive chemistry of natural products (glycerides, peptides, saccharides).
Reaction mechanisms (substitutions, additions, eliminations, condensations).
The citric acid cycle, the glyoxylate cycle.
Biosynthesis of terpenes.

**Literature**

Carsten Schmuck, Basisbuch Organische Chemie, Pearson

**Prerequisites / notice**

Der Stoff der Basischemie wird vorausgesetzt.

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**Basic Courses II: Examination Block 2**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-1551-00L</td>
<td>Ressourcen- und Umweltökonomie</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>L. Bretschger, A. Müller</td>
</tr>
</tbody>
</table>

Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalitas; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.
Objective

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

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

Content

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

Lecture notes

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

Literature


Basic Courses II: Additional Courses

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>752-0050-00L</td>
<td>Laboratory Course in Physics for Students in Food Sciences</td>
<td>O</td>
<td>2</td>
<td>4P</td>
<td>A. Biland, M. Münnich</td>
</tr>
</tbody>
</table>

Abstract

The central aim is to provide an individual experience of the physical phenomena and the basic principles of the experiment. By conducting simple physical experiments the student will learn how to properly use physical instruments and how to evaluate the results correctly.

Objective

- the setup of a physics experiment,
- the use of measurement instruments,
- various measuring techniques,
- the analysis or measurement errors,
- the interpretation of the measured quantities.

Content


The script and lecture material are available at:
https://moodle-app2.let.ethz.ch/course/view.php?id=1646 at latest 1 week before the beginning of the practical course.

Lecture notes

Anleitungen zum Physikalischen Praktikum

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>752-4003-00L</td>
<td>Practical Course in Microbiology</td>
<td>O</td>
<td>2</td>
<td>3P</td>
<td>M. Künzler</td>
</tr>
</tbody>
</table>

Abstract

Basic principles of the handling of microorganisms (MO) - Detection of MO in the environment - Foodmicrobiology - Morphology and diagnostics of MO - Morphology and physiology of fungi - Antimicrobial agents - Microbial genetics - Bacterial physiology and interactions - Microbial pest control

Objective

The students are familiar with the laboratory work with microorganisms. Specific emphasis is put on the isolation and maintenance of pure cultures and the required hygiene measures. The students know the practical, clinical and ecological importance of microorganisms.

Content

In an introductory part students are made familiar with the handling and cultivation of microorganisms (MO). Afterwards, the students detect MO in the environment and use MO for the conservation of food. This part is then followed by a practical introduction on routine diagnostics of MO and experiments with antimicrobial agents. The part on diagnostics is complemented by an overview over the morphology and physiology of fungi. On experiments on plant-bacteria-interactions - a current research topic at the Institute of Microbiology - the students experience the interaction of of MO with higher organisms. Some simple experiments demonstrate the importance of MO in molecular genetics. The course ends with an example of applied microbiology i.e. an experiment on microbial pest control.

Lecture notes

A detailed script of approx. 100 pp. and other relevant documents are available at https://moodle-app2.let.ethz.ch/course/view.php?id=1646 at latest 1 week before the beginning of the practical course.

A complete course document and/or a copy of the power point slides from each lecture will be provided.

Recommended literature (facultative):
- Allgemeine Mikrobiologie by Georg Fuchs and Hans G. Schlegel, Thieme-Verlag, 9. Auflage 2014
- Taschenlehrbuch Biologie: Mikrobiologie by Katharina Munk, Thieme Verlag, 2008

Prerequisites / notice

Performance of the students in this practical course is controlled by:
1. Attendance of all 7 course days
2. Giving a short communication to a selected topic of Microbiology (in groups of 3 students)
3. Handing in of written reports to selected experiments (in groups of 2 students)

Participating PhD students who collect credit points during their thesis are examined in a 30-minute oral exam at the end of the course.

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### Basics of Food Science

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<th>Number</th>
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<tbody>
<tr>
<td>752-1101-00L</td>
<td>Food Analysis I</td>
<td></td>
<td>3 credits</td>
<td>2V</td>
<td>T. Gude</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>To understand the basic principles of analytical chemistry. To get acquainted with the principles and applications of important routine methods of instrumental food analysis (UV/VIS, IR, AAS, GC, HPLC);</td>
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<td>To understand the basic principles of analytical chemistry. To get acquainted with the principles and applications of important routine methods of instrumental food analysis (UV/VIS, IR, AAS, GC, HPLC);</td>
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<td>Lecture notes</td>
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<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>a) Georg Schwedt, Analytische Chemie, 2. vollständig überarbeitete Auflage 2008</td>
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<td></td>
<td>b) R. Matissek, G. Steiner, M. Fischer, Lebensmittelanalytik, 5. Auflage 2014</td>
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### 5. Semester

#### Basics of Food Science

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<tr>
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<tbody>
<tr>
<td>752-5001-00L</td>
<td>Food Biotechnology I</td>
<td></td>
<td>4 credits</td>
<td>3V</td>
<td>L. Meile, M. Stevens</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>Basic information for understanding biotechnology applied to food processing will be presented. This will include a presentation of the physiology of important productive microorganisms used in food fermentations, closely related to applications in biotechnology; microbial kinetics, and design and operation of bioreactors; and application of modern molecular tools for food biotechnology.</td>
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<td>Objective</td>
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<td></td>
<td>The main goal for this course is to provide students with basic information for understanding biotechnology applied to food processing. For the students, the aim will be:</td>
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<td>- To understand the important role of microbial physiology and molecular tools for food biotechnology;</td>
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<td>- To understand basic principles of fermentation biotechnology, with particular emphasis on food applications.</td>
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<td>Content</td>
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<td>Biotechnology has been defined as any technique that uses living organisms, or substances from those organisms, to make or modify a product, to improve plants or animals, or to develop microorganisms for specific uses. In this course, basic knowledge for understanding biotechnology as applied to food processing will be presented. This course builds on the application of principles learned from other basic courses in the Bachelor program, especially microbiology and microbial metabolism, molecular biology, biochemistry, physics and engineering. Students will learn about the physiology of important productive microorganisms (lactic acid bacteria, bifidobacteria, propionibacteria and fungi) used in food fermentations, closely related to applications in biotechnology. Microbial kinetics, and design and operation of bioreactors used for both research and industrial scale production of traditional foods and modern food ingredients will be presented. This part will be illustrated by examples of food fermentation processes, representative of specific challenges. Finally, the application of modern molecular tools to food biotechnology will be discussed.</td>
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<td>Lecture notes</td>
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<td>A complete course document and/or a copy of the power point slides from each lecture will be provided.</td>
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<td></td>
<td>Literature</td>
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<td>A list of references will be given at the beginning of the course for the different topics presented during the course.</td>
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<tr>
<td>752-6001-00L</td>
<td>Introduction to Nutritional Science</td>
<td></td>
<td>3 credits</td>
<td>2V</td>
<td>M. B. Zimmermann, C. Wolfrum</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.</td>
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<td></td>
<td>To introduce the students to the both macro- and micronutrients in relation to food and metabolism.</td>
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<td>Content</td>
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<td>The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfram. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfram introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.</td>
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<td>Lecture notes</td>
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<td>There is no script. Powerpoint presentations will be made available.</td>
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<tr>
<td></td>
<td>Elmadad I &amp; Leitzmann C: Ernährung des Menschen</td>
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<td></td>
<td>UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004</td>
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<td></td>
<td>Garrow JS and James WPT: Human Nutrition and Dietetics</td>
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<td>Churchill Livingstone, Edinburgh, 11th rev. ed. 2005</td>
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<th>Hours</th>
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<tbody>
<tr>
<td>752-4005-00L</td>
<td>Food Microbiology I</td>
<td></td>
<td>3 credits</td>
<td>2V</td>
<td>M. Loessner</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>For students of the study programme Biology BSc the course can only be selected as 4th concept course.</td>
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<td>This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.</td>
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<td>The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.</td>
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<td>The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.</td>
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</tbody>
</table>
Content
1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP's of Food Microbiology
2. Overview of Microorganisms in Foods
   2.1. Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download.

Literature
Recommendations will be given in the first lecture

Food Science General Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>751-1101-00L</td>
<td>Finances and Accounting System</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>M. Dumondel</td>
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<tr>
<td>Abstract</td>
<td>To understand accounting as a component of the complex system of the enterprise</td>
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<tr>
<td>Objective</td>
<td>To understand accounting not as an isolated discipline, but as a part of the complex system of the enterprise</td>
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<tr>
<td>Content</td>
<td>Accounting system as a part of management economics. The different steps for scheduling and evaluation of the acountancy will be studied. The main part of the lecture is dedicated to the financial accounting nevertheless the fundamentals of the internal cost-accounting will also be presented. The lecture will also include the clarification of concrete cases and the calculation of practical exercises.</td>
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<tr>
<td>Lecture notes</td>
<td>Course documentation and specified educational books</td>
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<tr>
<td>Literature</td>
<td>In the lecture one indicates</td>
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</table>

| 551-0317-00L | Immunology I                               | W    | 3 credits | 2V | A. Oxenius, M. Kopf    |
| Abstract    | Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response. |
| Objective   | Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response. |
| Content     | - Introduction and historical background  
- Innate and adaptive immunity, Cells and organs of the immune system  
- B cells and antibodies  
- Generation of diversity  
- Antigen presentation and Major Histoincompatibility (MHC) antigens  
- Thymus and T cell selection  
- Autoimmunity  
- Cytotoxic T cells and NK cells  
- Th1 and Th2 cells, regulatory T cells  
- Allergies  
- Hypersensitivities  
- Vaccines, immune-therapeutic interventions |
| Lecture notes | Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien" |
| Prerequisites / notice | Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung". |

| 751-1307-00L | Managerial Economics Agri-Food Chain: Strategic Concepts | W    | 2 credits | 2G | B. Höltzchi, M. Weber  |
| Abstract    | Learn and exercise strategic concepts in the Agri-Food chain, i.e. theories of economics based decision making combined with entrepreneurial practice. |
| Objective   | The main objective is to understand strategic decisions along the value chain in the Agri-Food Chain. |
| Content     | - Basics of strategy & strategic concepts  
- Classic process of strategy process  
- Selected alternative processes  
- Case studies |
| Lecture notes | Dokuments will be distributed per lecture. |
| Literature  | Lombriser Roman & Aplanalp Peter: Strategisches Management |

| 752-2120-00L | Consumer Behaviour I                        | W    | 2 credits | 2V | M. Siegrist, C. Keller, B. S. Sütterlin |
| Abstract    | Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individuad determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior |

To procure students with the basics of mechanical process engineering with main focus on mechanical unit operations used in the food industry.

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

**752-1003-00L Food Chemistry II**

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<tbody>
<tr>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>L. Nyström, M. Erzinger</td>
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</table>

**Abstract**
To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

**Objective**
To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

**Content**
Descriptive chemistry of food constituents (proteins, lipids, carbohydrates, plant phenolics, flavour compounds). Reactions which affect the colour, flavour, texture, and the nutritional value of food raw materials and food products during processing, storage and preparation in a positive or in a negative way (e.g. lipid oxidation, Maillard reaction, enzymatic browning). Links to food analysis, food processing, and nutrition.

**The lectures Food Chemistry I and Food Chemistry II constitute a unit.**

**Literature**
The lectures are supplemented with handouts.


**752-1103-00L Food Analysis II**

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<tbody>
<tr>
<td>W+</td>
<td>1</td>
<td>1V</td>
<td>L. Nyström, M. Erzinger</td>
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</table>

**Abstract**
To get acquainted with the principles and applications of mass spectrometry in food analytics.

**Objective**
To get acquainted with the principles and applications of mass spectrometry in food analytics.

**Content**
Main focus: Mass spectrometry, applications of mass spectrometry (MS).

**The lectures are supplemented with handouts.**

**752-3001-00L Food Process Engineering II**

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<tr>
<td>W+</td>
<td>3</td>
<td>3G</td>
<td>E. J. Windhab</td>
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</table>

**Abstract**
To procure students with the basics of mechanical process engineering with main focus on technical unit operations used in the food industry.

**Objective**
Lecture and exercises

**Content**
Training in mechanical unit operations and understanding of their application in food processing.

Mechanische Verfahrenstechnik:

**Lecture notes**
The lectures are supplemented with handouts.

**Literature**
- Matthias Stiess, Mechanische Verfahrenstechnik Band. 1 & 2. Springer Verlag
- F. Löffler, J. Raasch, Grundlagen der Mechanischen Verfahrenstechnik, Vieweg Verlag

**Prerequisites / notice**
Voraussetzungen: Vorlesung in VTI, sowie physikalische und mathematische Grundkenntnisse

**752-2000-00L Food Materials Science**

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>4</td>
<td>3G</td>
<td>R. Mezzenga</td>
</tr>
</tbody>
</table>

**Abstract**
Principles of soft condensed matter applied to food polymers, surfactants and colloids

**Objective**
Understanding the fundamental physical principles ruling the self-assembly, aggregation, processing and structure-properties relationship in food systems constituted by polysaccharides (polymers), proteins (colloids) and lipids (surfactants).

**752-6307-00L Physiology and Anatomy III**

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>3</td>
<td></td>
<td>W. Langhans</td>
</tr>
</tbody>
</table>

**Abstract**
Imparts a basic understanding of physiology and anatomy in man, focusing on the interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. One major topic of the lecture is food intake and digestion with its correlated chemosensory, endocrine and metabolic processes.

**Objective**
At the end of the course the students understand the basic functions of the organ systems and functionally important morphological features. One focus of the course is on aspects related to nutrition and overweight including the resulting diseases.

**Food Science Laboratory Practice**

**Number**

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Food Microbiology</td>
<td>W</td>
<td>3</td>
<td>4P</td>
</tr>
</tbody>
</table>

**Objective**
To get acquainted with the principles and applications of mass spectrometry in food analytics.

**Content**
Teaching of basic experimental knowledge for detection and identification of relevant microorganisms in food. Various practical experiments were accompanied by theoretic introductions to the different topics. The students become acquainted with state-of-the-art methods with focus on modern molecular techniques for the rapid detection of food borne pathogens.

**Lecture notes**
Wird am Praktikumanfang abgegeben.

**Literature**
- Krämer: "Lebensmittel-Mikrobiologie" (Ulmer; UTB)
- Süssmuth et al.: "Mikrobiologisch-Biochemisches Praktikum" (Thieme)

**Prerequisites / notice**
During the course we will work with the food-borne pathogen Listeria monocytogenes. Listeria monocytogenes represents a particular threat in case of pregnancy. Due to biosafety reasons participation is not allowed in case of pregnancy.

**Bachelor Thesis**

**Number**

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor's Thesis</td>
<td>O</td>
<td>15</td>
<td>6D</td>
</tr>
</tbody>
</table>

**Abstract**
The Bachelor Thesis completes the Bachelor programme and consists of a scientific project carried out independently under the tutorship of a lecturer at D-HEST.
Objective
The Bachelor Thesis aims at fostering the student's ability to independent, structured and scientific working and at deepening their knowledge in a specific field.

▶ Complementary Courses

No acquisition of credits

<table>
<thead>
<tr>
<th>Food Science Bachelor - Key for Type</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td></td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td></td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td></td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td></td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td></td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td></td>
<td>Suitable for doctorate</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
### Educational Science

#### Human Learning (EW1)

**Title**: This lecture is only apt for students who intend to enrol in the programs "Teaching Diploma" or "Teaching Certificate". It is about learning in childhood and adolescence.

**Abstract**: This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

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

**Content**: Lernformen: Theorien und wissenschaftliche Konstrukte werden zusammen mit ausgewählten wissenschaftlichen Untersuchungen in Form einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde die Inhalte durch die Bearbeitung von Aufträgen in einem elektronischen Lerntagebuch. Über die Bedeutung des Gelernten für den Schulalltag soll reflektiert werden. Ausgewählte Tagebucheinträge werden zu Beginn jeder Vorlesung thematisiert.

**Lecture notes/Literature**

- Folien werden zur Verfügung gestellt.

**Prerequisites**

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

**ECTS**: 2 credits

**Hours**: 2G

**Lecturers**: E. Stern

#### Cognitive Activating Instructions in MINT Subjects (EW4)

**Title**: Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

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

**Objective**: - Get to know cognitively activating instructions in MINT subjects - Get information about recent literature on learning and instruction

**Prerequisites**

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

**ECTS**: 2 credits

**Hours**: 2S

**Lecturers**: R. Schumacher

#### Human Intelligence (EW1)

**Title**: Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

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

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

**ECTS**: 1 credit

**Hours**: 1S

**Lecturers**: E. Stern, P. Edelsbrunner, B. Rütsche

#### Research Methods in Educational Science (EW4)

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

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

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

**ECTS**: 1 credit

**Hours**: 1S

**Lecturers**: E. Stern, E. Ziegler

#### Coping with Psychosocial Demands of Teaching (EW4)

**Title**: Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

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

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

**ECTS**: 2 credits

**Hours**: 2S

**Lecturers**: A. Deiglmayr, P. Greutmann, S. Hofer
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching.

Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).

(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

### Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-9020-00L</td>
<td>Teaching Internship Including Examination Lessons</td>
<td>W</td>
<td>6 credits</td>
<td>13P</td>
<td>G. Kaufmann</td>
</tr>
</tbody>
</table>

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

### Further Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-9005-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Food Sc.</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>G. Kaufmann, K. Koch, U. Lerch</td>
</tr>
</tbody>
</table>

### Food Science TC - Key for Type

- O: Compulsory
- W+: Eligible for credits and recommended
- W: Eligible for credits
- E-: Recommended, not eligible for credits
- Z: Courses outside the curriculum
- Dr: Suitable for doctorate
<table>
<thead>
<tr>
<th>Key for Hours</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>V</td>
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<td></td>
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ECTS  European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Food Science Master

Major in Food Processing

Disciplinary Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-3103-00L</td>
<td>Food Rheology I</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>P. A. Fischer</td>
</tr>
<tr>
<td></td>
<td>Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloidal systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are introduced and discussed.</td>
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<tr>
<td></td>
<td>The concept of rheological constitutive equations and the application to different material classes. The course provides an introduction on the link between flow and structural properties of flowing material. Rheometrical techniques and appropriate measuring protocols for the characterization of complex fluids will be discussed.</td>
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<tr>
<td></td>
<td>Lectures will be given on general introduction (4h), fluid dynamics (4h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h).</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Notes will be handed out during the lectures.</td>
<td></td>
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</tbody>
</table>

| 752-2003-00L | Selected Topics in Food Technology | W+   | 3    | 2V    | J. Ubbink        |
|              | The focus of the lecture course is on both broadening and deepening the knowledge on food technology, and on providing an introduction to the context in which the food technologist will operate. The lecture course is developed from the perspective of the food technologist and the food developer, and will recapitulate and extend practical as well as fundamental aspects of food technology. |      |      |       |                  |
|              | - To revive the knowledge of the basic operations of food technology and to become acquainted with the principles and use of several advanced technologies. |      |      |       |                  |
|              | - To be able to quantitatively apply physical principles in the optimization of food processing and in the prediction of the shelf life of foods. |      |      |       |                  |
|              | - To be able to assess and select technologies to achieve specific aims in food processing and development. |      |      |       |                  |
|              | - To develop a basic understanding of contextual aspects impacting the work practice of food technologists and food developers. |      |      |       |                  |
|              | - To gain experience in the development of an R&D project in the wider food area. |      |      |       |                  |
|              | Lectures will be given on general introduction (4h), fluid dynamics (4h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h). |      |      |       |                  |
|              | Notes will be handed out during the lectures. |      |      |       |                  |

| 752-2314-00L | Physics of Food Colloids           | W+   | 3    | 2V    | P. A. Fischer, R. Mezzenga |
|              | In Physics of Food Colloids the principles of colloid science will applied to the aggregation of food material such as proteins, polysaccharides, and emulsifiers. Mixtures of such raw material determine the appearance and performance of our daily food. Examples of colloidal laws at work will link food colloid science to the manufacturing and processing of food. |      |      |       |                  |
|              | The underlying colloidal laws are reflecting the structure of the individual raw material (length scale, character of the interacting forces). Once those concepts are appreciated the aggregation of most food systems falls into recognizable patterns that can be used to modify and structure exiting food or to design new products. The application and use of those concepts are discussed in light of common food production. |      |      |       |                  |
|              | Lectures will be given on interfacial tension (4h), protein aggregation in bulk and interfaces (4h), Pickering emulsions (2h), polysaccharides (2h), aggregation of complex mixtures (4h), foams (2h), and the use of light scattering in investigation complex food structures (6h). Most chapters include some hand-on examples of the gain knowledge to common food products. |      |      |       |                  |
|              | Notes will be handed out during the lectures. |      |      |       |                  |

| 752-3021-00L | Food Process Design and Optimization | W+   | 4    | 2G    | E. J. Windhab    |
|              | Training by case studies from research and industrial production. |      |      |       |                  |
|              | Quantitative process analysis and derivation of process-structure functions for complex liquid or semi-liquid food systems with non-Newtonian flow properties. Handling of optimisation and up-/down-scaling procedures. |      |      |       |                  |
|              | S-PRO2 scheme, reverse engineering approach, dimension analysis, Metzner-Otto and Rieger Novack design schemes of stirred reactors for non-Newtonian fluid processing, mixing/mixing statistics, mixing characteristics, power characteristics, dispersing characteristics, dispersing processes in rotor/ stator and membrane devices, spray processing, extrusion processing, diverse case studies for design and scaling of processes for food structure processing |      |      |       |                  |
|              | Notes will be handed out during the lectures. |      |      |       |                  |

| Literature   | List of ca. 30 papers and 5 books given in course |      |      |       |                  |
The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on understanding the interplay of in-line measurements of complex food properties in processes, process data handling and data analysis as well as building blocks for process control.

Lecturers

W+


Content

Overview Process Automation, Process Control and process data management, Industrial design of automated/controlled processes, overview on sensors/sensor principles, case studies of in-line measurements and control in/of food production processes

Lecture notes

Printed script (120 pages, 80 figures), diverse publications

Literature

List of publications and books given in course

Prerequisites / notice

VT I-III

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### Methodology Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W+</td>
<td>5</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

Abstract

Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content


Lecture notes

see website

Literature


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W+</td>
<td>5</td>
<td>2V+1U</td>
<td>M. Dettling</td>
</tr>
</tbody>
</table>

Abstract

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content

The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Lecture notes

A script will be available.

Literature

Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

Prerequisites / notice

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

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### Optional Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-1301-00L</td>
<td>Special Topics in Toxicology</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. J. Sturla</td>
</tr>
</tbody>
</table>

Abstract

Journal-club style course involving student presentations and active discussion and critique of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester

Objective

- to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences
- to develop skills in critical evaluation of scientific literature, oral presentation and questioning
- to understand modern experimental techniques and research approaches relevant to Toxicology

Content

The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).

Literature

A selection of approximately 20 papers from recent primary scientific literature.
The course is open to Masters or PhD level students. For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-1302-00L</td>
<td>Advanced Topics in Toxicology</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>S. J. Sturla</td>
</tr>
</tbody>
</table>

Abstract: Journal-style course that involves student presentations of selected topics in Toxicology on the basis of current primary research and review papers.

Objective: The goals are to stimulate student interest and provide advanced knowledge of current research in the interdisciplinary area of Food and Nutritional Toxicology and its related sciences. The student should develop skills in the critical evaluation of scientific literature, oral presentation and questioning, and understanding modern experimental techniques in Molecular Toxicology.

Content: The journal-style course involves student presentations of recent publications. The primary focus is on chemical and biochemical aspects of selected topics in Toxicology. Participants are generally masters or PhD students in Food Sciences and related disciplines (i.e. Food and Pharmaceutical Sciences, etc.), and strong knowledge of organic chemistry and biochemistry are prerequisite. Selected course topics change every semester.

Prerequisites / notice: Participants are required to have completed previously "Special Topics in Toxicology" (752-1301-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for "Advanced Topics in Toxicology" until after you have completed "Special Topics in Toxicology".

## Major in Food Quality and Safety

### Disciplinary Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-0801-00L</td>
<td>Food Law and Legislation</td>
<td>W+</td>
<td>1</td>
<td>V</td>
<td>C. Spinner, E. Zbinden Kaessner</td>
</tr>
</tbody>
</table>

Abstract: Principles of the Swiss food law, introduction to the principles of the EU, international organisations and bilateral contracts.

Objective: Overview of the general principles, institutions and execution of the Swiss food law as well as a presentation of the most important regulations of the Swiss food legislation. Knowledge about the principles and the structure of the EU in general and in the area of food safety, overview on the bilateral agreements CH-EU as well as on the most important international organisations (Codex Alimentarius and WTO) and their influence on the Swiss regulations on food safety.

Content: General introduction into the EU and in the area of food safety (Directorate General SANCO, regulation on food safety), legislative procedure in the EU, introduction into the relevant bilateral agreements CH-EU, introduction into international organisations (e.g. Codex Alimentarius), general principles of the Swiss food law and the most important regulations as well as the most important legal procedures, legal settlement and the duties and responsibilities of the Food control authorities.

Lecture notes: Copies of the presentations will be handed out.

Literature: Documents about Codex Alimentarius, the EU as well as the Swiss food law and some regulations will be handed out.

Prerequisites / notice: Qualifications: General knowledge of the food sciences. The lecture will be held in German.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>752-1021-00L</td>
<td>Selected Topics in Food Chemistry (HS)</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>L. Nyström</td>
</tr>
</tbody>
</table>

Abstract: Two major topics of the course are I. Enzymes in Food Sciences and II. Molecular Gastronomy.

Objective:

I. To understand use of enzymes in food processing and analysis.

II. To explain the physicochemical features of ingredients and reactions applied in molecular gastronomy.

Content: I. Enzymes in foods: the use of added enzymes in food processing, control and/or utilization of endogenous enzymes, production of enzyme preparations for food use, and chemical analysis of food components by enzymatic methods.

II. Case studies in modern molecular gastronomy: phenomena, chemicals, reactions and techniques applied.

Lecture notes: The lectures are supplemented with handouts.

Literature: The lectures will be held in German.

Prerequisites / notice: Course prerequisites: Food Chemistry I/II and Food Analysis I/II (or equivalent)

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. Loessner, M. Schuppler</td>
</tr>
</tbody>
</table>

Abstract: The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective: Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Content: Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc.) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment ? What can be done to interfere with the potential risks?

Lecture notes: Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature: Recommendations will be given in the first lecture.

Prerequisites / notice: Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
</tbody>
</table>

Abstract: This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Objective: To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.
Content

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- Legal and Protection Issues Related Functional Foods

- Industrial Biotechnology of Flavor and Taste Development

- Safety of Food Starter Cultures and Probiotics

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

Lecture notes

Copy of the power point slides from lectures will be provided.

Literature

A list of references will be given at the beginning of the course for the different topics presented during this course.

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Topics in Toxicology</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. J. Sturla</td>
</tr>
</tbody>
</table>

Abstract

Journal-club style course involving student presentations and active discussion of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester.

Objective

- To stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences
- To develop skills in critical evaluation of scientific literature, oral presentation and questioning
- To understand modern experimental techniques and research approaches relevant in Toxicology

Content

The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).

Literature

A selection of approximately 20 papers from recent primary scientific literature.

Notice

The course is open to Masters or PhD level students.

Prerequisites / notice

For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>Advanced Topics in Toxicology</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. J. Sturla</td>
</tr>
</tbody>
</table>

Abstract

Journal-club style course that involves student presentations of selected topics in Toxicology on the basis of current primary research and review papers.

Objective

The goals are to stimulate student interest and provide advanced knowledge of current research in the interdisciplinary area of Food and Nutrition Toxicology and its related sciences. The student should develop skills in the critical evaluation of scientific literature, oral presentation and questioning, and understanding modern experimental techniques in Molecular Toxicology.

Content

The journal-club style course involves student presentations of recent publications. The primary focus is on chemical and biochemical aspects of selected topics in Toxicology. Participants are generally masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Pharmaceutical Sciences, etc.), and strong knowledge of organic chemistry and biochemistry are prerequisite. Selected course topics change every semester.

Prerequisites / notice

Participants are required to have completed previously "Special Topics in Toxicology" (752-1300-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for "Advanced Topics in Toxicology" until after you have completed "Special Topics in Toxicology".

Methodology Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W+</td>
<td>5</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

Abstract

Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content


Lecture notes

see website

Literature


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W+</td>
<td>5</td>
<td>2V+1U</td>
<td>M. Dettling</td>
</tr>
</tbody>
</table>

Abstract

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Lecture notes
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

#### Optional Subjects

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-5111-00L</td>
<td>Gene Technology in Foods</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>L. Meile</td>
</tr>
</tbody>
</table>

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

#### Major in Nutrition and Health

#### Disciplinary Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-2307-00L</td>
<td>Nutritional Aspects of Food Composition and Processing</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>B. E. Baumer, J. M. Sych</td>
</tr>
</tbody>
</table>

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

#### Major in Nutrition and Health

#### Disciplinary Subjects

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. Eichholzer</td>
</tr>
</tbody>
</table>

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Objective
Students are able to:
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

<table>
<thead>
<tr>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-6402-00L</td>
<td>Nutrigenomics - toward personalized nutrition?</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>G. Vergères</td>
</tr>
<tr>
<td>Abstract</td>
<td>Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.</td>
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<tr>
<td>Objective</td>
<td>- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics. - Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science. - Ability to critically evaluate the potential and risks associated with the field of nutrigenomics</td>
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<tr>
<td>Content</td>
<td>- For the content of the script see section &quot;Skript&quot; below - The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.</td>
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<tr>
<td>Lecture notes</td>
<td>The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules</td>
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</tr>
<tr>
<td>Literature</td>
<td>No extra reading requested. Most slides in the lecture are referenced with web addresses.</td>
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<tr>
<td>Prerequisites</td>
<td>Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.</td>
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</thead>
<tbody>
<tr>
<td>752-1301-00L</td>
<td>Special Topics in Toxicology</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. J. Sturla</td>
</tr>
<tr>
<td>Abstract</td>
<td>Journal-club style course involving student presentations and active discussion and critique of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester</td>
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<tr>
<td>Objective</td>
<td>- to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences - to develop skills in critical evaluation of scientific literature, oral presentation and questioning - to understand modern experimental techniques and research approaches relevant in toxicology</td>
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</tr>
<tr>
<td>Content</td>
<td>The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Literature</td>
<td>A selection of approximately 20 papers from recent primary scientific literature.</td>
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<tr>
<td>Prerequisites</td>
<td>The course is open to Masters or PhD level students.</td>
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<tr>
<td>notice</td>
<td>For Masters level participants, a strict prerequisite is (a) previously taken and passed &quot;Introduction to Molecular Toxicology&quot; (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.</td>
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</table>

For you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

### Methodology Subjects

<table>
<thead>
<tr>
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<th>Hours</th>
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<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W+</td>
<td>5</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
<tr>
<td>Abstract</td>
<td>Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.</td>
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<tr>
<td>Objective</td>
<td>Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.</td>
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<tr>
<td>Lecture notes</td>
<td>see website</td>
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</table>
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products.

The practical course nutrient analysis in foods includes the preparation and chemical analysis of meals from different types of diets. The analyses comprise energy, macronutrients, specific micronutrients as well as polyphenols and phytic acid. Based on the results the nutritional value of each meal is critically evaluated and discussed. The practical work is accompanied by a lecture on the basic principles of analytical chemistry.

Students will work in groups. Attendance in compulsory for the lecture and the laboratory work. Performance is assessed by a short test on course content, results presentation and a short report.

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

The practical course is accompanied by a lecture on the basic principles of analytical chemistry.

The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short writen report.

A list of references will be given at the beginning of the course for the different topics presented during this course.
Abstract
Gives the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand.

Objective
Some basic knowledge in physiology is recommended for this course, which revisits important physiological topics, emphasizing their relation to nutrition. The aim is to give the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand. For students with a background in medicine, pharmacy or biology, the course is useful as a review of previously acquired knowledge. Major topics are basic neuroanatomy and neuropsychiology; general endocrinology; the physiology of taste and smell; nutrient digestion and absorption; intermediary metabolism and energy homeostasis; and some aspects of cardiovascular physiology and water balance.

752-6403-00L Nutrition and Performance
W+ 2 credits 2V S. Mettler, M. B. Zimmermann

Abstract
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

Objective
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

Content
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture notes
Lecture slides and required handouts will be available on the ETH website.

Literature
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Prerequisites / notice
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English
It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

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

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

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

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

Lecture notes
Copies of slides from lectures will be provided.

Literature
Actual publications from literature will be provided.

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

752-1302-00L Advanced Topics in Toxicology
W 2 credits 2G S. J. Sturla

Abstract
Journal-club style course that involves student presentations of selected topics in Toxicology on the basis of current primary research and review papers.

Objective
The goals are to stimulate student interest and provide advanced knowledge of current research in the interdisciplinary area of Food and Nutrition Toxicology and its related sciences. The student should develop skills in the critical evaluation of scientific literature, oral presentation and questioning, and understanding modern experimental techniques in Molecular Toxicology.

Content
The journal-club style course involves student presentations of recent publications. The primary focus is on chemical and biochemical aspects of selected topics in Toxicology. Participants are generally masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Pharmaceutical Sciences, etc.), and strong knowledge of organic chemistry and biochemistry are prerequisite. Selected course topics change every semester.

Prerequisites / notice
Participants are required to have completed previously "Special Topics in Toxicology" (752-1301-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for "Advanced Topics in Toxicology" until after you have completed "Special Topics in Toxicology"

Major in Human Health, Nutrition and Environment
Definition of modules see study guide Food Science

Disciplinary Subjects
Disciplinary courses: Module Public Health plus one additional module (Infectious Desease or Nutrition and Health or Environment and Health). A minimum of 10 CP per module have to be obtained

Number Title Type ECTS Hours Lecturers
401-0629-00L Applied Biostatistics W 4 credits 3G M. Müller

Abstract
Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.

Objective
Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the sult.

Content

Lecture notes

Literature

Prerequisites / notice

The statistical package R will be used in the exercises. If you are unfamiliar with R, I highly recommend the online R course etutoR.
### 551-0223-00L Immunology III

| W | 4 credits | 2V | M. Kopf, M. Bachmann, J. Kisielow, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spiroiri |

**Abstract**
This course provides a detailed understanding of:
- development of T and B cells
- the dynamics of an immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies

**Objective**
Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

**Content**
- development of different types of T cells and their effector mechanisms during immune responses
- recognition of pathogenic microorganisms by the host cells and molecular events thereafter
- events and signals for maturation of naïve B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines
- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the “Danger” concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

**Literature**
Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=998

**Prerequisites / notice**
Immunology I and II

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### 551-1171-00L Immunology: from Milestones to Current Topics

| W | 4 credits | 2S | B. Ludewig, M. Kopf, A. Oxenius, University lecturers |

**Abstract**
Milestones in Immunology: an old concepts and modern experiments

**Objective**
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptional framework and critical technological advancements. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

**Content**
- T cell function and dysfunction in acute and chronic viral infections
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter
- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

**Literature**
Original and review articles will be distributed by the lecturer.

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

| W | 3 credits | 2G | D. Croll, S. Bonhoeffer, R. R. Regoś |

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

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

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

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

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

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### 701-1341-00L Water Resources and Drinking Water


**Abstract**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

**Objective**
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

**Content**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

**Lecture notes**
Handouts will be distributed

**Literature**
Will be mentioned in handouts

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### 752-2122-00L Food and Consumer Behaviour

| W | 2 credits | 2V | M. Siegrist, C. Hartmann, V. Visschers |

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

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

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### 752-4009-00L Molecular Biology of Foodborne Pathogens

| W | 3 credits | 2V | M. Loessner, M. Schuppler |

**Abstract**
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

**Objective**
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganisms or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.
R. Heusser
There is no script. Powerpoint presentations will be made available on-line to students.

Epidemiology and Prevention

Nutrigenomics

2V

C. Lacroix
Functional Microorganisms in Foods

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products. Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

752-5103-00L Functional Microorganisms in Foods W 3 credits 2G C. Lacroix, T. de Wouters, L. Meile, C. Schwab

Abstract
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Objective
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

Content
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

M. B. Zimmermann
Nutrition and Chronic Disease (HS) W 3 credits 2V M. B. Zimmermann

752-6101-00L Nutrition and Chronic Disease (HS) W 3 credits 2V M. B. Zimmermann

Abstract
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

Content
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

752-6105-00L Epidemiology and Prevention W 3 credits 2V M. Eichholzer

Abstract
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Objective
Students are able:
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

Content
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

752-6151-00L Public Health Concepts W+ 3 credits 2V R. Heusser

Abstract
The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

Objective
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Content
Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

752-6402-00L Nutrigenomics W 3 credits 2V G. Vergères

Abstract
The module "Nutrigenomics" offers an introduction to the intersection of genomics and nutrition. Students get acquainted with the concepts and methods of genomics and how they apply to nutrition. Students also learn to use genomics data for nutrition research and applications.

Objective
At the end of this module students are able:
- to interpret the results of genomics studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of nutrition
- to plan public health interventions and health promotion projects

Content
Concepts of descriptive and analytical genomics, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, nutrigenomics and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).
Abstract
Nutrigenomics - toward personalized nutrition?
Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food science.

Objective
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understanding of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics

Content
- For the content of the script see section "Skript" below
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.

Lecture notes
The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
Nutritional genomics

Module C
Nutrigenetics

Module D
Nutri-epigenomics

Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualization - opportunities and challenges

Literature
No extra reading requested. Most slides in the lecture are referenced with web addresses.

Prerequisites / notice
Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

Methodology Subjects
Methodical courses are equivalent to the module Term Paper and Seminar. Missing CPs can be obtained from the major programs Food Processing, Food Quality and Safety, or Nutrition and Health.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---

Abstract
Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.

Objective
- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising of academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

Content
Topics are offered in the domains of the major ‘Human Health, Nutrition and Environment’ covering ‘Public Health’, ‘Infectious Diseases’, ‘Nutrition and Health’ and ‘Environment and Health’.

Lecture notes
Guidelines will be handed out in the beginning.

Literature
Literature will be identified based on the topic chosen.

Optional Subjects
Choice of a module not yet selected as a disciplinary course. Choice between Infectious Diseases, Nutrition and Health, and Environment and Health.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
752-4009-00L | Molecular Biology of Foodborne Pathogens | W+ | 3 credits | 2V | M. Loessner, M. Schuppler

Abstract
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature
Recommendations will be given in the first lecture

Prerequisites / notice
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.
Immunology III

Objective
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Content
Milestones and current topics of innate immunity, antigen presenting, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Lecture notes
Original and review articles will be distributed by the lecturer.

Literature
Literaturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app2.let.ethz.ch/course/view.php?id=1002

551-0223-00L Immunology III

Abstract
This course provides a detailed understanding of
- development of T and B cells
- the dynamics of a immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies

Objective
Obtain a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effector mechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.

Content
- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

Literature
Documents of the lectures are available for download at:
https://moodle-app2.let.ethz.ch/course/view.php?id=998

Prerequisites / notice
Immunology I and II
This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

**Functional Microorganisms in Foods**

T. de Wouters, L. Meile, S. Hug

Copy of the power point slides from lectures will be provided.

3 credits

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

**Molecular Evolution, Phylogenetics and Phylodynamics**

T. Stadler

4 credits

The course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterisation of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

Students will be required to complete a group project on food products and ingredients with or from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

**Food and Consumer Behaviour**

M. Siegrist, C. Hartmann, V. Visschers

2 credits

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

**Water Resources and Drinking Water**

S. Hug, M. Berg, F. Hammes, U. von Gunten

2G

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

**Literature**

A list of references will be given at the beginning of the course for the different topics presented during this course.

Lecture notes

Handouts will be distributed

**Notice**

No extra reading requested. Most slides in the lecture are referenced with web addresses.

**Prerequisites / notice**

Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.
The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:
- models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:
- epidemiology
- pathogen evolution
- macroevolution of species

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Slides of the lecture will be available online.

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Basic knowledge in linear algebra, analysis, and statistics.

### Food Biotechnology

#### 752-5103-00L Functional Microorganisms in Foods

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
</tbody>
</table>

This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety, and potential health benefits for consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

Some content will be provided by registered students who will individually or as a group present an actual publication.

### Literature

- Additional publications from literature will be provided.

### Notice

- Attendance at lectures is mandatory.
- Exams will be oral and may be in either German or English.
- Examination attempts after the course is finished may be allowed under certain circumstances.

### Prerequisites

- Sound knowledges in microbiology, molecular genetics, biochemistry and physiology in fermentd beverages are required.

### Content

- Composition of a distillery. What is pre-run, middle-run and post-run? What are quality parameters by spirits.
- Destillates: Beer Production: Processes in the brewhouse, malting, diacetylmangement.
- Wine Production: Where is the origin of the microorganisms for winemaking? What are dry yeasts? What is the meaning of spontaneous alcoholic fermentation? What is a "pied de cuve"? What is the influence of wine yeasts on the aroma of the wines? What is the role of glycerol in wine? What is the optimal temperature fermentation? What do we understand under the name biogenic amines? What is the reason for the occurrence of stuck fermentation? What is the meaning of "Bökser"? What is untypical ageing of wines? Which is the influence of Brettanomyces bruxellensis yeasts on wine quality - the wine "spanidggl"? What is the task of malolactic fermentation (BSA)? What do we understand under Lindton? What are the reasons for vinagre taint? Diacetylmangement in wine? Where does the mice taint origin? Which are desired and which are undesired yeasts and bacteria? How can we determine the genotype of grape varieties? What do we understand under cork taint (Zapfen)? Which wine bottle closures are on the market? - a quality analysis. What happens during the filtration process? What is the role of gentechology in winemaking? Attendees will apply these concepts to a number of applications yielding biological insight into:
- epidemiology
- pathogen evolution
- macroevolution of species
Content

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- **Probiotics and Prebiotics:** Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- **Bioprotective Cultures and Antimicrobial Metabolites:** Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- **Legal and Protection Issues Related Functional Foods**

- **Industrial Biotechnology of Flavor and Taste Development**

- **Safety of Food Starter Cultures and Probiotics**

Students will be required to complete a group project on food products and ingredients with and from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short write report.

Lecture notes

Copy of the power point slides from lectures will be provided.

Literature

A list of references will be given at the beginning of the course for the different topics presented during this course.

### Food Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>752-1021-00L</td>
<td>Selected Topics in Food Chemistry (HS)</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>L. Nyström</td>
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</table>

**Abstract**

Two major topics of the course are: 1. Enzymes in Food Sciences and II. Molecular Gastronomy.

**Objective**

I. To understand use of enzymes in food processing and analysis.

II. To explain the physicochemical features of ingredients and reactions applied in molecular gastronomy.

**Content**

I. Enzymes in foods: the use of added enzymes in food processing, control and/or utilization of endogenous enzymes, production of enzyme preparations for food use, and chemical analysis of food components by enzymatic methods.

II. Case studies in modern molecular gastronomy: phenomena, chemicals, reactions and techniques applied.

Lecture notes

The lectures are supplemented with handouts.

Prerequisites / notice

Course prerequisites: Food Chemistry I/II and Food Analysis I/II (or equivalent)

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<thead>
<tr>
<th>Number</th>
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<tr>
<td>529-0041-00L</td>
<td>Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano, Sinues</td>
</tr>
</tbody>
</table>

**Abstract**

Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

**Objective**

Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

**Content**

Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation.

Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods.

Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods).

Employment of computer science for processing data in chemical analysis (chemometrics).

**Lecture notes**

Lecture notes will be available in the lecture at production cost.

**Literature**

Information about relevant literature will be available in the lecture & in the lecture notes.

Exercises are an integral part of the lecture.

Prerequisites:

529-0051-00 "Analytische Chemie I (3. Semester)"

529-0058-00 "Analytische Chemie II (4. Semester)"

(or equivalent)

### Food Microbiology

<table>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Loessner, M. Schuppler</td>
</tr>
</tbody>
</table>

**Abstract**

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

**Objective**

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

**Content**

Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

**Lecture notes**

Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

**Literature**

Recommendations will be given in the first lecture

**Prerequisites / notice**

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
</tbody>
</table>

**Abstract**

This integration course will discuss new applications of microorganisms with functional properties in food and functional foods products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

**Objective**

To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- Legal and Protection Issues Related Functional Foods

- Industrial Biotechnology of Flavor and Taste Development

- Safety of Food Starter Cultures and Prebiotics

Students will be required to complete a group project on food products and ingredients with or from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

Overview on Process Automation, Information Management in processes, process data handling and analysis, In-line measurements of complex food systems, Process control schemes, reverse engineering approach, dimension analysis, Metzner-Otto and Rieger Novack design schemes of stirred reactors. Process characterisation by dimension analysis. Training by case studies from research and industrial production.

Detailed Course:

Food Process Design

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<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-3021-00L</td>
<td>Food Process Design and Optimization</td>
<td>W</td>
<td>4</td>
<td>2</td>
<td>E. J. Windhab</td>
</tr>
</tbody>
</table>

Objective

Content

Lecture notes

Literature

Prerequisites / notice

Process Measurements and Automation

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-3023-00L</td>
<td>Process Measurements and Automation</td>
<td>W</td>
<td>3</td>
<td>2</td>
<td>E. J. Windhab</td>
</tr>
<tr>
<td>Abstract</td>
<td>Overview on Process Automation, Information Management in processes, process data handling and analysis, In-line measurements of complex food systems, Process control schemes, Overview of sensors and sensor principles, integrated process control case studies Understanding the interplay of in-line measurements of complex food properties in processes, process data handling and data analysis as well as building blocks for process control.</td>
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<tr>
<td>Objective</td>
<td>Understanding the interplay of in-line measurements of complex food properties in processes, process data handling and data analysis as well as building blocks for process control.</td>
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Content

Lecture notes

Literature

Prerequisites / notice

Public Nutrition and Health

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W</td>
<td>3</td>
<td>2</td>
<td>M. Eichholzer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.</td>
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Objective

Content

Lecture notes

Literature

Prerequisites / notice

Facts of the course:

Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.
Objective

Students are able
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

Content

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>751-1555-00L</td>
<td>Food Economics</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>A. Champetier de Ribes</td>
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<tr>
<td>Abstract</td>
<td>Food Economics proposes to explore important issues in food production, supply, and consumption using the concepts and tools of microeconomics.</td>
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<tr>
<td>Objective</td>
<td>The two objectives of the class are:</td>
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<td>- to provide an overview of the important issues related to food markets and supply chains.</td>
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<td></td>
<td>- to present the economics concepts and tools that are useful to understand the functioning of food supply chains under various governance regimes or policies (emphasis on welfare analysis)</td>
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<tr>
<td>Content</td>
<td>The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include: Demand for food. Matching demand with supply. Industrial organization in the food supply chain. Non-quality attributes of food. When information is costly. Food production and the environment. The food sector within human economies.</td>
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<td></td>
<td>In addition, the students collectively identify and address an applied research question. We implement an empirical strategy to tackle the question before results are discussed individually by students during the final written examination.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes are made available after each lecture.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students are expected to master basic microeconomics concepts such as demand, supply, or consumer and producer surplus. We will review how to calculate elasticities, tax and quota impacts on prices etc...but the class focuses on applications of these tools rather than on basic understanding. Students are expected to have taken at least one intermediary microeconomics class.</td>
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<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann, V. Visschers</td>
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<tr>
<td>Abstract</td>
<td>This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.</td>
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<tr>
<td>Objective</td>
<td>The course provides an overview of the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues</td>
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<tr>
<td>752-2307-00L</td>
<td>Nutritional Aspects of Food Composition and Processing</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>B. E. Baumer, J. M. Sych</td>
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<tr>
<td>Abstract</td>
<td>Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing.</td>
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<tr>
<td>Objective</td>
<td>Students should be able to</td>
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<td>- describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food</td>
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<td>- apply these criteria when assessing the effects of selected processing technologies on nutritional quality.</td>
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<td>- evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods).</td>
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<tr>
<td>Content</td>
<td>The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed.</td>
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<tr>
<td>Lecture notes</td>
<td>There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.</td>
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<tr>
<td>751-2401-00L</td>
<td>Food and Agricultural Trade Policy</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>R. Jörin</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution. By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.</td>
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<td>Objective</td>
<td>Objectives</td>
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<tr>
<td></td>
<td>1. Knowledge of the mechanisms of agricultural trade</td>
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<td>2. Impact of trade policy instruments on welfare and distribution</td>
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<td></td>
<td>3. Specific aspects of agricultural trade and links to other courses:</td>
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<td></td>
<td>- Trade and food security</td>
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<td>- Trade and environment</td>
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<tr>
<td></td>
<td>- Trade and development</td>
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<td>Content</td>
<td>The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution. By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts (power point presentations)</td>
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</table>
The Forum “Livestock in the World Food System” will take place in blocks of 2 hours each. Once the general topic has been selected, it

Documents handed out during the case studies.

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

Lecturer

Documents handed out during the case studies.

As provided by the case study leaders.

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

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

The content framework includes the following modules: world food system overview; agricultural production; Global change drivers; food; information on the legislation in Switzerland and EU-countries.

Criteria of rationale food safety and health assessment in agriculture and food consumption will be elaborated.

of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU. Criteria of rationale food safety and health assessment in agriculture and food consumption will be elaborated.

the participating student.

followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.

the remaining students and lecturers are the audience.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Language: spoken E, G or F, Documents: Preferably English, G/F possible.
**Physics of Food Colloids**

- **Abstract**: Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloidal systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are introduced and discussed.

- **Objective**: The concept of rheological constitutive equations and the application to different material classes. The course provides an introduction on the link between flow and structural properties of flowing material. Rheometrical techniques and appropriate measuring protocols for the characterization of complex fluids will be discussed.

- **Content**: Lectures will be given on general introduction (4h), fluid dynamics (4h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h).

- **Lecture notes**: Notes will be handed out during the lectures.

- **Literature**: Provided in the lecture notes.

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**Special Topics in Toxicology**

- **Number**: 752-1301-00L
- **Title**: Special Topics in Toxicology
- **Abstract**: Journal-club style course involving student presentations and active discussion and critique of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester

- **Objective**: -to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences
- -to develop skills in critical evaluation of scientific literature, oral presentation and questioning
- -to understand modern experimental techniques and research approaches relevant in Toxicology

- **Content**: The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).

- **Literature**: A selection of approximately 20 papers from recent primary scientific literature.

- **Prerequisites / notice**: The course is open to Masters or PhD level students.

For Masters level participants, a strict prerequisite is (a) previously taken and passed “Introduction to Molecular Toxicology” (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

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**Advanced Topics in Toxicology**

- **Number**: 752-1302-00L
- **Title**: Advanced Topics in Toxicology
- **Abstract**: Journal-club style course that involves student presentations of selected topics in Toxicology on the basis of current primary research and review papers.

- **Objective**: The goals are to stimulate student interest and provide advanced knowledge of current research in the interdisciplinary area of Food and Nutrition Toxicology and its related sciences. The student should develop skills in the critical evaluation of scientific literature, oral presentation and questioning, and understanding modern experimental techniques in Molecular Toxicology.

- **Content**: The journal-club style course involves student presentations of recent publications. The primary focus is on chemical and biochemical aspects of selected topics in Toxicology. Participants are generally masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Pharmaceutical Sciences, etc.), and strong knowledge of organic chemistry and biochemistry are prerequisite. Selected course topics change every semester.

- **Prerequisites / notice**: Participants are required to have completed previously “Special Topics in Toxicology” (752-1301-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for “Advanced Topics in Toxicology” until after you have completed “Special Topics in Toxicology”

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**Risk Assessment of Chemicals**

- **Number**: 529-0047-00L
- **Title**: Risk Assessment of Chemicals
- **Abstract**: Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.

- **Objective**: Project thesis (report) on chemicals assessment; time frame totals ca. 80 hours.

- **Content**: Projects on chemical assessment with the focus on the following aspects:

  * Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety,
  * Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications,
  * Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis,
  * Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty,
  * Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

- **Lecture notes**: See recommended literature.
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Students are able to evaluate the scientific evidence on the effects of diet on human health, to describe the role of nutritional factors in the prevention of chronic diseases, to assess the nutritional status of a population (Switzerland taken as an example), to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic.

The main goal for this course is to provide students with topics on current research in Food Science and related fields from which the student can choose. They have to select an individual topic and present it in the presence of a small number of selected specialists in the particular field.

The Master thesis completes the master programme and is an independent scientific project. Generally, the topic is selected from the specific field of the major. It is supervised by a professor at D-HEST.

The Master Thesis must demonstrate the student’s ability to independent, structured and scientific working.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>752-6005-00L</td>
<td>Public Colloquium in Food Science</td>
<td>W</td>
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<td>L. Meile</td>
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<td>752-0230-00L</td>
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## Electives

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<tr>
<td>752-0005-00L</td>
<td>Public Colloquium in Food Science</td>
<td>W</td>
<td>1</td>
<td>2K</td>
<td>L. Meile</td>
</tr>
</tbody>
</table>

## Master Thesis

- Only students who fulfill the following criteria are allowed to begin with their master thesis:
  - a. successful completion of the bachelor programme;
  - b. fulfilling of any additional requirements necessary to gain admission to the master programme.

- The topic of the thesis and if they are not Professors of D-HEST - the examiner and the co-examiner have to be approved by the D-HEST Department Conference.

- The Master thesis completes the master programme and is an independent scientific project. Generally, the topic is selected from the specific field of the major. It is supervised by a professor at D-HEST.

- The Master Thesis must demonstrate the student’s ability to independent, structured and scientific working.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
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<tr>
<td>W</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
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<tr>
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### Key for Hours

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<thead>
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<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
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</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
MAS in Architecture and Digital Fabrication

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>065-0061-00L</td>
<td>MAS in Architecture and Digital Fabrication</td>
<td>E-</td>
<td>0</td>
<td>7K</td>
<td>F. Gramazio, M. Kohler</td>
</tr>
</tbody>
</table>

Abstract

The MAS ETH in Architecture and Digital Fabrication is an interdisciplinary education programme initiated by the National Centre of Competence in Research (NCCR) Digital Fabrication and the ETH Zurich. The focus lies upon the methods and techniques of digital design and fabrication and their significance for future building culture.

Objective

The NCCR Digital Fabrication is an ambitious initiative that brings together leading researchers in the disciplines of architecture, engineering, robotics, material and computer sciences. As the main education platform for this NCCR, the MAS ETH in Architecture and Digital Fabrication will benefit from direct exchange with its investigators and immediate access to cutting edge research and innovation. In the NCCR's unique robotic fabrication facilities, the students will also have the opportunity to research digital design and construction processes, and to implement these directly in large-scale prototypes.

The MAS ETH in Architecture and Digital Fabrication is conceived as a 12 months full-time programme targeted at university graduates with excellent design skills and technical knowledge. The teaching language of the programme will be English. The programme begins on the 14th of September 2015. Applications will be accepted until the 30th of April 2015.

Participants will develop competence in complex design and production challenges and will be able to take leading positions in the field of architecture, construction, or the extended design and production industries.

Content

The MAS Digital Fabrication is a 1 year full-time programme and is structured as a series of teaching modules with an independent master thesis. Lessons within the modules are given in the form of lectures, practical workshops, and projects as the main modus for developing skills. Learning will be supported through one on one mentoring in studio, group critiques, symposia, and excursions.

Prerequisites / notice

A Master's degree in architecture or engineering acknowledged by ETH, or equivalent educational qualifications (i.e. a bachelor's degree and a minimum of two years professional experience in a directly related field). Additional critical requirements are proof of creative design skills and technological capabilities. Qualification will be assessed from application documents and skills will be evaluated through portfolio review.

MAS in Architecture and Digital Fabrication - Key for Type

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

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<tr>
<td>R</td>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Architecture and Information

The studies take one full year and begin in the autumn semester.

The programme contains 75 CP and is divided into about 6-8 modules of 3-4 weeks, which are taught in seminars that are each concluded with an individual or group project. The studies end with an individual thesis.

For more information about the modules please visit: http://www.caad.arch.ethz.ch/

Teaching languages are English and German. The number of participants is 6 to 12.

Courses Offered

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<td>E-</td>
<td>0</td>
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<td>L. Hovestadt</td>
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</table>

Abstract

A fundamental theoretical and practical introduction to the application of information technologies in architecture. The MAS program CAAD is a yearly full time program, consisting of eight 4-weekly instruction modules with practical exercises and a concluding individual Masterthesis.

Objective

Development of new design methods, new construction forms, media architectures, narrative infrastructures, global models. Parametric and generative CAD systems, procedural, object-oriented and agent-based programming, introduction to JAVA/Processing, introduction to diverse computer-controlled machines with practical examples, development of machine-compatible building constructions, development of electronics for automated tasks, implementation of radio networks.

Content

http://www.mas.caad.arch.ethz.ch/

Lecture notes

http://www.mas.caad.arch.ethz.ch/

Literature

http://www.mas.caad.arch.ethz.ch/

MAS in Architecture and Information - Key for Type

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

Key for Hours

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

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Development and Cooperation

The lectures and advanced training courses of NADEL are accessible only for students of the MAS in Development and Cooperation and for qualified employees with at least two years experience in development cooperation. PhD-students doing empirical research in development cooperation may be admitted "sur Dossier".

Courses Offered

<table>
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<tr>
<th>Number</th>
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<td>865-0000-01L</td>
<td>Planning and Monitoring of Projects</td>
<td>W</td>
<td>2</td>
<td>3G</td>
<td>R. Battiner, F. Brugger</td>
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<td>Only for MAS/CAS in Development and Cooperation</td>
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<td></td>
<td>students, as well as specialists with at least 24 months of practical experience in international cooperation. Doctoral students dealing with empirical research in the area of development and cooperation (EZA) may be admitted &quot;sur Dossier&quot;.</td>
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<td>Objective</td>
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<td></td>
<td>The course provides an introduction to the methodology of results-based planning and steering of development projects. The course enables participants to use the most important instruments for project planning and for building an outcome-oriented monitoring system.</td>
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<td>865-0000-06L</td>
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<td>3G</td>
<td>I. Günther</td>
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<td>The course gives an introduction to the most important methods for rigorous impact analysis of development programs and projects. The course is designed to both cover the most fundamental methods of impact analysis and introduce real world case studies from national, international and non-governmental development organizations and asks how rigorous impact analysis has influenced their policies.</td>
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<td>Content</td>
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<td></td>
<td>Introduction to rigorous impact analysis; Case studies and their policy implications; Introduction to the required statistical knowledge; Potentials and limitations of quantitative analysis; Experimental and quasi-experimental methods; Relevant and feasible indicators for the measurement of outcomes and impacts; Data collection and analysis; Project management of an impact analysis.</td>
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<td>Prerequisites / notice</td>
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<td>865-0037-00L</td>
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<td>3G</td>
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<td>Objective</td>
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<td></td>
<td>The course conveys basic theoretical and empirical knowledge about private sector promotion in development assistance. The main focus is on measures to promote small and medium enterprises (SMEs).</td>
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<td>Content</td>
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<td>The course conveys basic theoretical and empirical knowledge about private sector promotion in development assistance. The course conveys basic theoretical and empirical knowledge about private sector promotion in development assistance.</td>
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<tr>
<td>865-0065-02L</td>
<td>Participatory Approaches and Qualitative Methods</td>
<td>W</td>
<td>2</td>
<td>3G</td>
<td>L. B. Nilsen, R. Battiner</td>
</tr>
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<td>Only for MAS/CAS in Development and Cooperation</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>Develop the participants' knowledge and understanding of qualitative research design, and enable them to apply participatory methods at various stages of the project cycle.</td>
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<td></td>
<td>Content</td>
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<td></td>
<td>Key topics include: - The concepts of facilitation and participation. - Effective communication and facilitation in groups. - Quantitative versus qualitative research design. - Key tools and practices for collecting, visualizing and assessing data in a community.</td>
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<tr>
<td>865-0000-10L</td>
<td>Non-Renewable Resources - Fueling Development or</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>F. Brugger</td>
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<td>Undertaking the Future</td>
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</table>

The course gives an introduction into the development challenges of resource-dependent economies from regulating extraction and extractive companies to promoting local linkages and managing revenues. It explores how international cooperation can support sustainable development outcomes.

<table>
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<th>Title</th>
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<tbody>
<tr>
<td>865-0000-03L</td>
<td><strong>Topical Issues of Development Cooperation</strong></td>
<td>Doctoral students dealing with empirical research in the area of development and cooperation (EZA) may be admitted &quot;sur Dossier&quot;.</td>
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<tr>
<td>865-0000-11L</td>
<td><strong>Fragile Contexts - Politics, Security and Development</strong></td>
<td>Doctoral students dealing with empirical research in the area of development and cooperation (EZA) may be admitted &quot;sur Dossier&quot;.</td>
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<tr>
<td>865-0065-00L</td>
<td><strong>Vocational Education and Training between Poverty Alleviation and Economic Development</strong></td>
<td>Doctoral students dealing with empirical research in the area of development and cooperation (EZA) may be admitted &quot;sur Dossier&quot;.</td>
</tr>
</tbody>
</table>

The course explores characteristics of fragility and how they are measured and monitored. It further discusses cooperation between actors (peace building, security, humanitarian, development cooperation) and explores how development programming has to be adapted to these situations.

The participants are able to:
- Assess project proposals and ongoing project regarding their relevance and suitability in the specific country context
- Explain strengths and weaknesses of the opposing approaches "dual apprenticeship" and "competency based training" as well as synergies and incompatibilities between the two
- Describe the competent use of tools currently applied in VET

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- Assess project proposals and ongoing project regarding their relevance and suitability in the specific country context
- Explain strengths and weaknesses of the opposing approaches "dual apprenticeship" and "competency based training" as well as synergies and incompatibilities between the two
- Describe the competent use of tools currently applied in VET

Students of the course must fulfil requirements specified on the homepage of NADEL. Electronic registration may be done only after registration with NADEL secretariate.
### MAS in Nutrition and Health

#### Disciplinary Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
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<td>752-6402-00L</td>
<td>Nutrigenomics - toward personalized nutrition?</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>G. Vergères</td>
</tr>
<tr>
<td>Abstract</td>
<td>Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.</td>
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<tr>
<td>Objective</td>
<td>- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.</td>
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<tr>
<td>Content</td>
<td>- Overall understanding of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.</td>
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<td>- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics</td>
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<tr>
<td>Lecture notes</td>
<td>The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules</td>
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<tr>
<td>Literature</td>
<td>Module A - From biochemical nutrition research to nutrigenomics</td>
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<td>Module B - Nutritional genomics</td>
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<td>Module C - Nutrigenetics</td>
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<td>Module E - Transcriptomics in nutrition research</td>
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<td>Module G - Metabolomics in nutrition research</td>
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<td>Module H - Nutritional systems biology</td>
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<td>Module I - Individualized nutrition - opportunities and challenges</td>
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<td>Prerequisites / notice</td>
<td>Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.</td>
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| 752-6105-00L | Epidemiology and Prevention | W+   | 3 credits | 2V    | M. Eichholzer    |
| Abstract     | The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. |
| Objective    | Students are able |
|             | - to evaluate the scientific evidence on the effects of diet on human health |
|             | - to describe the role of nutritional factors in the prevention of chronic diseases |
|             | - to assess the nutritional status of a population (Switzerland taken as an example) |
|             | - to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic |
| Content      | The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed. |

| 752-2307-00L | Nutritional Aspects of Food Composition and Processing | W+   | 3 credits | 2V    | B. E. Baumer, J. M. Sych |
| Abstract     | Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing. |
| Objective    | Students should be able to |
|             | - describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food |
|             | - apply these criteria when assessing the effects of selected processing technologies on nutritional quality. |
|             | - evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods). |
| Content      | The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed. |
| Lecture notes| There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course. |
| Prerequisites / notice | The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as knowledge of food processing. |

| 752-6301-00L | Selected Topics in Physiology Related to Nutrition | W+   | 3 credits | 2V    | W. Langhans      |
| Abstract     | Gives the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand. |
### 766-6205-00L Nutrient Analysis in Foods

- **Number of participants limited to 20.**

**Abstract**
In this practical course different meals are prepared and then analyzed in the laboratory. The analyses comprise energy, macronutrients, specific micronutrients as well as polyphenols and phytic acid. Based on the results the nutritional value of each meal is critically evaluated and discussed. The practical work is accompanied by a lecture on the basic principles of analytical chemistry.

**Objective**
Knowing analytical methods to determine macro- and micronutrient content in foods. Critical evaluation of analytical results and interpretation in relation to nutritional value of meals.

**Content**
The practical course nutrient analysis in foods includes the preparation and chemical analysis of meals from different types of diets. The content of macronutrients, specific micronutrients and secondary plant components are analyzed using common analytical methods. The analytical results are compared with calculated data from food composition databases and critically evaluated. The nutritional values of the meals in relation to specific chronic diseases are discussed. The practical course is accompanied by a lecture on the basic principles of analytical chemistry.

**Lecture notes**
A script and lecture slides are handed out before the start.

**Prerequisites / notice**
Students will work in groups.

**Attendance in compulsory for the lecture and the laboratory work.**
Performance is assessed by a short test on course content, results presentation and a short report.

### 752-6101-00L Nutrition and Chronic Disease (HS)

- **W** 3 credits 2V M. B. Zimmermann

**Abstract**
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes**
There is no script. Powerpoint presentations will be made available on-line to students.

**Literature**
To be provided by the individual lecturers, at their discretion.

**Prerequisites / notice**
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

### 752-6403-00L Nutrition and Performance

- **W** 2 credits 2V S. Mettler, M. B. Zimmermann

**Abstract**
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

**Objective**
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

**Content**
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

**Lecture notes**
Lecture slides and required handouts will be available on the ETH website.

**Literature**
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

**Prerequisites / notice**
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise performance and related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

### Electives

#### Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
752-2122-00L | Food and Consumer Behaviour | W | 2 credits | 2V | M. Siegrist, C. Hartmann, V. Visschers

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

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

752-0801-00L | Food Law and Legislation | W | 1 credit | 1V | C. Spinner, E. Zbinden Kaessner

**Abstract**
Principles of the Swiss food law, introduction to the principles of the EU, international organisations and international contracts.

**Objective**
Overview about the general principles, institutions and execution of the Swiss food law as well as a presentation of the most important regulations of the Swiss food legislation. Knowledge about the principles and the structures of the EU in general and in the area of food safety, overview on the bilateral agreements CH-EU as well as on the most important international organisations (Codex Alimentarius and WTO) and their influence on the Swiss regulations on food safety.

**Content**
General introduction into the EU and in the area of food safety (Directorate General SANCO, regulation on food safety), legislative procedure in the EU, introduction into the relevant bilateral agreements CH-EU, introduction into international organisations (e.g. Codex Alimentarius), general principles of the Swiss food law and the most important regulations as well as the most important legal procedures, legal settlement and the duties and responsibilities of the Food control authorities.

**Lecture notes**
Copies of the presentations will be handed out.

**Literature**
Documents about Codex Alimentarius, the EU as well as the Swiss food law and some regulations will be handed out.

**Prerequisites / notice**
Qualifications: General knowledge of the food sciences.

The lecture will be held in German.

752-5103-00L | Functional Microorganisms in Foods | W | 3 credits | 2G | C. Lacroix, T. de Wouters, L. Meile, C. Schwab
Abstract
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Objective
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

Content
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- Bioprotective Cultures and Antimicrobial Metabolites: Antilungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- Legal and Protection Issues Related Functional Foods

- Industrial Biotechnology of Flavor and Taste Development

- Safety of Food Starter Cultures and Probiotics

Lecture notes
Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

Literature
Copy of the power point slides from lectures will be provided.

A list of references will be given at the beginning of the course for the different topics presented during this course.

752-5111-00L Gene Technology in Foods W 3 credits 2V L. Meile
Abstract
This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course also assesses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

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

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

551-0317-00L Immunology I W 3 credits 2V A. Oxenius, M. Kopf
Abstract
Introduction into structural and functional aspects of the immune system.

Objective
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Content
- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

572-6151-00L Public Health Concepts W+ 3 credits 2V R. Heusser
Abstract
The module “public health concepts” offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

Objective
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Content
Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

752-6031-00L Master Thesis
Number
Title
Type
ECTS
Hours
Lecturers

MAS Master’s Thesis

Only for MAS in Nutrition and Health.

Abstract
The study program is completed with the Master thesis, an independent scientific work. Topics are selected within the domains of the MAS program. The work is supervised by a lecturer of the MAS program.

Objective
The Master thesis must demonstrate the student’s ability to independent, structured and scientific working.

MAS in Nutrition and Health - Key for Type

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<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
<td>Compulsory</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Eligible for credits and recommended</td>
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<td>Dr</td>
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Key for Hours

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ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Abstract
The MAS program “Competency in the Building Process” provides graduates of the program with a thorough understanding of the complexities of a project, instilling them with an increased capacity to assess the consequences of their actions and decisions. Upon successful completion of the studies, graduates are qualified to assume the complex duties of an overall project leader in building projects.

Objective
Over the course of the MAS program, students review and closely examine professional experiences gained so far. The goal of the program is to develop an understanding and form opinions on the present-day building process. The course directs students to draw independent conclusions and set forecasts for design professionals in the building process, creating a basis, in conjunction with group discussions, for independent study.

Content
The Master of Advanced Studies in «Competency in the Building Process» imparts an integral view of the building process. Ever-changing technical and social demands, complex permit processes and increasing pressure to speed up production and completion times have led to the fragmentation and specialization of services and work performed by building process participants. Maintaining an overview of the project are the architects and engineers, who draw from a broad knowledge base as they direct, coordinate and moderate all disciplines involved in the design and construction process.

The MAS program «Competency in the Building Process» is a part-time study for professionally experienced architects and engineers. It provides graduates of the program with a thorough understanding of the complexities of a project, instilling them with an increased capacity to assess the consequences of their actions and decisions. Upon successful completion of the studies, graduates are qualified to assume the complex duties of an overall project leader in building projects.

The first three semesters of the study are comprised of: «Construction Participants», «Services» and «Strategies Interests». Explored in the first semester is communication as it relates to qualifications, acquisition and the organisation chart of the participating client, architects and design and construction professionals. The second semester then turns to the building process as a sequence of activities, placing its focus on basic principles and the services, i.e., the commission for design services, the service model, relevant economic considerations, the overall project leader, coordination of specialty engineers and the project leader. Over the course of the third semester, correlations are then drawn between the topic areas as they relate to the strategies and interests of building industry players. An in-depth look is also taken at the competencies of design professionals. The masters thesis in the fourth and final semester completes the course of study.

Over the course of the MAS program, students review and closely examine professional experiences gained so far. The goal of the program is to develop an understanding and form opinions on the present-day building process. The course directs students to draw independent conclusions and set forecasts for design professionals in the building process, creating a basis, in conjunction with group discussions, for independent study.

Literature
Literaturempfehlungen unter www.bauprozess.arch.ethz.ch
Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009
The MAS-programm in “History and Theory of Architecture” is a two-year half-time course and contains 60 CP. The course starts in the autumn semester.

Attendance of classes supplemented by independent research; practical training periods and excursions; lectures/seminars on one to two days per week, in total 600 ca. contact hours, in addition private study ca. 600 hours (for each in-class day one day of work preparation), two individually tutored seminar papers on chosen subjects (200 hours) and credited Master’s thesis (600 hours).

Courses Offered

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<td>0 credits</td>
<td>4V</td>
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Abstract

The program aims at enhancing students' understanding of subject matter and methods in the field of research into architectural theory and at assisting them in the critical investigation of the history and theory of architecture.

Objective

The historical and social roots of architecture are an essential aspect of the work of architects. To adapt the past to ones own thinking and knowledge, is a challenge. This will be done in a lively and reflecting process. Anyone faced with this challenge in the practical work will find a quality for his buildings that can't be reached by only considering urbanistic, aesthetic and functional factors.

Based on selected issues, the participants of the MAS-program «Geschichte und Theorie der Architektur» get acquainted with the methods of historic research. Participants will gain a deeper insight into the subjects and methods of architectural historians and will be supported in scientific discourses.

Content

The MAS-program «Geschichte und Theorie der Architektur» includes a weekly four-hour seminar in which the techniques of scientific work (methodology, creating a bibliography, researching, textual criticism, editing) and practicing essential aspects of art and architecture are discussed on the basis of texts and buildings before they are written down in textual form.

Historiographical and methodological aspects as well as training in analyzing and describing architectural phenomena are at the forefront. A major concern is also to improve the ability for writing of texts (encyclopedia articles, short essays, project descriptions, academic papers). Writing is a key instrument not only of disciplinary discourse, but also the public exchange of research.

Depending on the topic of the course, there is a single or multi-day trip, during which the participants talk about the buildings that are visited. In addition, each semester, at least two additional courses of the Institute gta have to be visited.

The course concludes with a diploma thesis written on a subject that is chosen by the students. The concept and writing of this work are intended to be a process that evolves continuously while studying. The thesis can be extended into a dissertation, provided the student has a graduate degree that is acknowledged by the ETH.

Mas in History and Theory of Architecture (GTA) - Key for Type

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

Key for Hours

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

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Housing

The course offered within the MAS-programm "Housing" is classified in four relevant modules:

- Module 1: social and historical context of housing, housing design and construction.
- Module 2: Housing design, past and present: Typology, building, biography of usage.
- Module 3: Housing as a contribution of urban design and neighborhood development.
- Module 4: Sustainable development - a new goal in housing design and construction.

Also see separate program.

The attendance of the lecture "Housing" of Prof. Eberle in the autumn semester is compulsory.

Individual chosen 3-4 further lectures or seminars in the Autumn or Spring Semester have to be attended (6 CP).

The modules 3 and 4 are offered in the Spring Semester.

Courses Offered

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<td>E-</td>
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<td>M. A. Glaser</td>
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Abstract

Relevant issues about the provision, the design and the construction of housing and quality of living are explored based on an interdisciplinary analysis. The MAS thesis is focused on studying, for example, the interdependence of architectural, social, spatial and urban planning considerations, and shifting demand and usage patterns related to housing.

Objective

Against the backdrop of jointly developed theoretical ideas, the students job-related skills and accomplishments in the fields of drawing up concepts, analysis, interpretation, and conversion as well in oral and written conveying are consolidated and expanded in discussions and in joint work. The course of study does not strive to train generalists. Instead it deals with the formulation of questions and procedures elaborated by the students in a generalistic or interdisciplinary way. This is the decisive factor in the qualitative added value of methods which span over several disciplines.

MAS in Housing - Key for Type

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ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Landscape Architecture

The Master of Advanced Studies in Landscape Architecture is a one-year full time postgraduate diploma programme delivered in English. It deals mainly with a scale of landscape that is between that of project design and landscape planning. The focus is on peripheral landscapes and their integration into our cities. In the context of the MAS LA these are discussed and developed in respect to their contemporary functional, ecological and aesthetic potentials. Language: English, contact hours: 600h.

For further information please visit: http://www.girot.arch.ethz.ch/

Courses Offered

The programme is a one-year full time master programme, structured a-round two main poles: a landscape design studio (laboratory), and a theory seminar (oratory). Emphasis within the programme on Landscape Video will also help provide a strong analytical basis in both theory and design. The studies are held during the semester from Tuesday to Friday. The programme will conclude with an individual thesis work.

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<th>Number</th>
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Abstract

Within the "Master of Advanced Studies in Landscape Architecture" (MAS LA), the use of the latest modeling and visualization possibilities as well as the actual 3D depiction of landscape architecture make up the core emphasis. Here, the focus lies on the integration of CAD/CAM technologies as a design-supporting medium.

Objective

Through an intensive investigation of the latest software and techniques, the students are capable of the following:

- Represent complex design tasks
- Develop spatial perception at different levels of scales
- Handle current problems efficiently and experimentally
- Develop new visualization and communication techniques using new media
- Communicate design ideas professionally

Content

The MAS LA is a one-year (academic) postgraduate diploma programme delivered in English. It is divided into themed modules and a concluding synthesis module. The chosen CAD programs (i.e. Rhino) are particularly appropriate for the visualization of large-scale landscape designs and offer the possibility for export to computer-steered milling machines. In addition, superior competency enhancement in the area of 3D GIS and the use of photography as a design tool and video as tool for illustration and design round off the goal-oriented program.

MAS in Landscape Architecture - Key for Type

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

Key for Hours

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

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Introduction to Management

Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.

Objective
- Know effects of work design on competence, motivation, and well-being
- Understand links between design of individual jobs and work processes
- Know basic processes involved in systematic organizational change
- Understand the interaction between organization and technology and its impact on organizational change
- Understand relevance of work design for company performance and strategy
- Know and apply methods for analyzing and designing work
- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterium
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

Content
- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterium
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

Literature
A list of required readings will be provided at the beginning of the course.


Selected readings from the book and additional learning materials will be available on the course Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=1287

All the materials uploaded on Moodle must be considered as required readings.

Supplementary Seminar to Introduction to Marketing - B2B Marketing

Exclusively for MAS MTEC students (first semester).
A parallel enrolment for the lecture Introduction to Marketing (363-0403-00) in the same semester is mandatory.
Limited number of participants: a minimum of 10 persons and a maximum of 60 persons.
Please register by 22.09.2015 at the latest via myStudies.

The seminar extends the "Introduction to Marketing" course by taking a look at the characteristics of B2B markets, particularly at the situation of manufacturing firms.

**Objective**
By analyzing their firm's business model, the students gain deeper insights into the challenges that companies have to face today and into the recommendations that modern marketing theory offers.

**Content**
Companies operating on B2B markets increasingly face global competition and demanding customers. One way out is to customize the company's core offering and to enhance it with additional products and services. However, these "business solutions" are often not as profitable as expected; the underlying business model needs improvement.

In this seminar, the participants analyze their company's business model with regard to its suitability for business solutions. The firm does not have to be a solution provider; the seminar also encourages the students to think about new pathways to increase the competitiveness of the companies they are working for.

**Prerequisites / notice**
The focus of the seminar is on B2B companies. Therefore, the employer of the participants should primarily serve business customers (as opposed to end consumers, e.g. for fast moving consumer goods). Manufacturing and service companies are equally suitable. Students should have a basic understanding of their firm's business model.

### Information Management, Operations Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0445-00L</td>
<td>Logistics, Operations and Supply Chain Management I W+</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Schönsleben, E. Scherer Casanova</td>
<td></td>
</tr>
<tr>
<td>363-0421-00L</td>
<td>Management Information Systems</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Fleisch</td>
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</tr>
</tbody>
</table>

**Abstract**
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

**Objective**
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

**Content**
Strategic and tactical concepts in logistics, operations, and supply chain management: Conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the MRP II / ERP concept: business processes and methods; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.

**Literature**

This book also serves as textbook for LOS II (spring termn) as well as ERP and SCM software systems (autumn term). In addition powerpoint-handouts and documents for case studies.

Sales at 17.9.15, from 12:45, before and during brakes of the first lecture.

see "script"

As for the lecture of the 3rd week (BEMAD, a much-liked Business Engineering and Management Ability Development game), this lecture (of Oct. 1) will follow a specific schedule in specific rooms. The schedule will be presented at Sept. 17 during the 1st lecture.

Due to the big number of students, about half of the students will play this game, instead of Oct. 1, at Friday afternoon, Oct. 2. Please be available. Thank you for your help in this matter.

Students know how to measure & evaluate investments into the digital space as

- a decision maker in an established company (should I invest in project A or B?)
- an entrepreneur (should I pursue this venture?)
- an investor (should I invest in start-up xy?)

B. The student knows different tools to design digital business model patterns.
Content
Uber, Airbnb, Nest and Jawbone - A wide range of innovative companies exist, which successfully implemented ICT enabled business models and continue to grow at a rapid pace. Examples, illustrating how digitalization, including the "Internet of Things" currently fosters business model innovation across various industries. This course is designed to help students to understand and critically assess such newlyimmerging (digital) business models.

For the lecture students will get access to one of the leading online teaching platforms (called edX) also offered by other top universities (incl. MIT, Harvard, Berkeley, etc.). Using the edX platform, will allow students to collaborate in online discussions, solve online exercises and present a short educational video as part of a group project.

Key Topics:
- Business model innovation; (digital) business model patterns; business value of IT; the concept of integration; transaction cost perspective;
- network economics perspective; essentials and impact of web 2.0; internet of things; mobile computing; market places, social analytics and big data; IT governance and portfolio management; entrepreneurship in the digital space, etc.

Quantitative and Qualitative Methods

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W+</td>
<td>3</td>
<td>3G</td>
<td>F. Schweitzer, P. Mavrodiev</td>
</tr>
</tbody>
</table>

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

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

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

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

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

Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0565-00L</td>
<td>Principles of Macroeconomics</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>J.E. Sturm</td>
</tr>
</tbody>
</table>

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significant do international economic relations have for Switzerland?

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

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

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

We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.
Principles of Microeconomics

W+ 3 credits 2G M. Filippini

Abstract
The course introduces basic principles, problems and approaches of microeconomics.

Objective
The course includes the following main topics:

Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

Lecture notes
Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature
N. Gregory Mankiw and Mark P. Taylor (2014), "Economics", 3rd edition, South-Western Cengage Learning. The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:

Complementary:

Financial Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0711-00L</td>
<td>Accounting for Managers</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>J.P. Chardonnens</td>
</tr>
</tbody>
</table>

Abstract
Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

Objective
Understand the different procedures involved in the accounting system
Record change in financial position
Measure business income
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Content
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,
Managerial Accounting: Full costing, variable costing, cost-volume profit, break-even analysis, activity-based costing

Prerequisites / notice
This course is a prerequisite for the course Financial Management.

3. Semester

Core Courses

Strategy, Technology and Innovation Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0392-00L</td>
<td>Strategic Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>G. von Krogh</td>
</tr>
</tbody>
</table>

Abstract
This course conveys concepts and methods in strategic management, with a focus on competitive strategy. Competitive strategy aims at improving and establishing position of firms within an industry.

Objective
The lecture "strategic management" is designed to teach relevant competences in strategic planning and implementation, for both professional work-life and further scientific development. The course provides an overview of the basics of strategy and the most prevalent concepts and methods in strategic management. The course is given as a combination of lectures about concepts/methods, and case studies where the students asked to solve strategic issues of the case companies. In two sessions, the students will also be addressing real-time strategic issues of firms that are represented by executives.

Content
Contents:
a. Introduction to strategy
b. Industry dynamics I: Industry analysis
c. Industry dynamics II: Analysis of technology and innovation
d. The resource-based theory of the firm
e. The knowledge-based theory of the firm
The goal of the course is that participants are able to transfer and use the concepts and methods from the Strategic Management lecture to their real-life contexts and organizations. Please register simultaneously for both courses if you want to take part in this course.

For more information please see: http://www.smi.ethz.ch/education/practicing-strategy.html
Effective supply chains ought to be aligned with and support the achievement of the firms corporate, business and product strategies. Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, the task of designing and managing supply chains requires that managers apply strategic, decision making and leadership skills in a changing corporate and market environment. The course offers an introduction to the theory and practice of supply chain management. Students will learn how to develop supply chain strategies and supply chain networks based on the firm's competitive strategies and marketing priorities.

The lecture treats the main challenges of business transformation and the alignment of corporate development and IT activities. It presents a holistic approach to business transformation projects by introducing an integrated model dealing with three main design areas: "strategy", "processes" and "information systems" and applying this model to various case studies.

The globalization of the world leads to an increasingly faster pace in business transformation. Enterprises have to adapt faster and even faster to the environmental changes in a global economy to remain competitive and to make sure they stay in business. In today's information age this does not only mean to adapt business strategy and business processes but also to adapt information systems to the new circumstances. The fast adaptation through large scale corporate transformation projects that change strategy, business processes and information systems is critical to ensure competitiveness for tomorrow. The introduction of new business processes and information systems typically takes years in very complex large scale projects. Many projects fail because of insufficient alignment between decision makers in business and IT. Unclear understanding of the overall project scope, undefined roles and responsibilities, unclear project processes, quality problems and resistance to change are some typical problems found in such projects. The lecture is subdivided into following modules:

1. Corporate development introduction and motivation
2. Parallelization of corporate development and complexity reduction
3. Planning process and project portfolio management in corporate development
4. Management of large scale projects integration of strategy, processes and information systems
5. Quality management in large scale projects
6. Project management in large scale projects

Change management within projects. The lecture is accompanied by four case studies that are used to exemplify the contents of the lecture by applying the concepts to real situations in corporate life.

### Quantitative and Qualitative Methods

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
363-0305-00L | Empirical Methods in Management | W+ | 3 credits | 2G | A. Scherer

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

**Abstract**

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

**Content**

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

Bi-weekly out-of-class assignments and projects on covered subjects
363-1004-00L Operations Research  W+  3 credits  2G  M. Laumanns
Abstract
This course provides an introduction to operations research methods in the fields of management science and economics. Requisite mathematical concepts are introduced with a practical, problem-solving perspective.
Objective
- Introduction to building and using quantitative models in a business / industrial environment
- Introduction to basic optimization techniques (Linear Programming and extensions, network flows, integer programming, dynamic and stochastic optimization)
- Understanding the integration of quantitative models into the managerial decision process

Content
The following topics are covered: Systems and models, linear models and the importance of linear programming, duality theory and shadow prices, integer programming, optimization under uncertainty and applications in inventory management.

Lecture notes
A printed script will be made available.

Literature
Any standard textbook in Operations Research is a useful complement to the course.

Prerequisites / notice
Undergraduate calculus, linear algebra, probability and statistics are a prerequisite.

363-0537-00L Resource and Environmental Economics  W+  3 credits  2G  L. Bretschger, A. Brausmann
Abstract
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.
Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

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

Lecture notes
Learning material and script can be found here: https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature

363-0561-00L Financial Market Risks  W+  3 credits  2G  D. Sornette
Abstract
I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.
Objective

The course explains the key concepts and mechanisms of financial economics, their depth and then stresses how and why the theories and models fail and how this is impacting investment strategies and even a global view of citizenship, given the present developing crises in the US since 2007 and in Europe since 2010.

- Development of the concepts and tools to understand these risks and master them.
- Working knowledge of the main concepts and tools in finance (Portfolio theory, asset pricing, options, real options, bonds, interest rates, inflation, exchange rates)
- Strong emphasis on challenging assumptions and developing a systemic understanding of financial markets and their many dimensional risks

Content

1. The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.

2. Risks in financial markets
   - What is risk?
   - Measuring risks of financial assets
   - Introduction to three different concepts of probability
   - History of financial markets, diversification, market risks

3. Introduction to financial risks and its management.
   - Relationship between risk and return
   - Portfolio theory: the concept of diversification and optimal allocation
   - How to price assets: the Capital Asset Pricing Model
   - How to price assets: the Arbitrage Pricing Theory, the factor models and beyond

4. Financial markets: role and efficiency
   - What is an efficient market?
   - Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
   - Deviations from efficiency, puzzles and anomalies in the financial markets
   - Financial bubbles, crashes, systemic instabilities

5. An introduction to Options and derivatives
   - Calls, Puts and Shares and other derivatives
   - Financial alchemy with options (options are building blocks of any possible cash flow)
   - Determination of option value; concept of risk hedging

6. Valuation and using options
   - A first simple option valuation model
   - The Binomial method for valuing options
   - The Black-Scholes model and formula
   - Practical examples and implementation
   - Realized prices deviate from these theories: volatility smile and real option trading
   - How to imperfectly hedge with real markets?

7. Real options
   - The value of follow-on investment opportunities
   - The timing option
   - The abandonment option
   - Flexible production
   - Conceptual aspects and extensions

8. Government bonds and their valuation
   - Relationship between bonds and interest rates
   - Real and nominal rates of interest
   - Term structure and Yields to maturity
   - Explaining the term structure
   - Different models of the term structure

9. Managing international risks
   - The foreign exchange market
   - Relations between exchanges rates and interest rates, inflation, and other economic variables
   - Hedging currency risks
   - Currency speculation
   - Exchange risk and international investment decisions

Lecture notes

Lecture slides will be available on the site of the lecture

Literature

Corporate finance
Brealey / Myers / Allen
Eight edition

+ Additional paper reading provided during the lectures

Prerequisites / notice

none

363-0723-00L Corporate Finance W+ 3 credits 2G M. Neuhaus

Abstract

Corporate Finance, investment management, business valuation, value based management & compensation, financial reporting today & in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers & acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls & mgmt. information systems, turnaround.

Objective

Introduction in theory and practical application of Corporate Finance, with a particular focus on financing of operations and transactions, analysed from multiple aspects, including legal and tax.

Content

Corporate Finance, investment management, business valuation, value based management and compensation, financial reporting today and in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers and acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls and management information systems, turnaround.
### Electives, 1. and 3. Semester

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0311-00L</td>
<td>Psychological Aspects of Risk Management and Technology</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>G. Grote, S. A. Maurer, J. Schmutz, R. Schneider, M. Zumbühl</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Using uncertainty management by organizations and individuals as conceptual framework. Risk management and risk implications of new technologies are treated. Three components of risk management (risk identification/evaluation, risk mitigation, risk communication) and underlying psychological and organizational processes are discussed. The course will cover: understanding basic components of risk management in organizations, risk communication, psychological and organizational concepts relevant in risk management, decision-making under uncertainty, resilient organizational processes for managing uncertainty, case studies on different elements of risk management (e.g., rule making, training, managing project risks, automation), group projects related to company case studies.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>The syllabus includes the following topics: Elements of risk management - risk identification and evaluation, risk mitigation, - risk communication, Psychological and organizational concepts relevant in risk management - decision-making under uncertainty, - risk perception, - resilient organizational processes for managing uncertainty, Case studies on different elements of risk management (e.g., rule making, training, managing project risks, automation), Group projects related to company case studies.</td>
</tr>
<tr>
<td>365-0351-00L</td>
<td>Presentation Skills</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>T. Skipwith</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>This course will cover how to prepare and deliver your future presentations. You will be more confident presenting yourself. Thanks to the feedback from your colleagues, the trainer and the video you will be able to identify your strengths and weaknesses.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>The participants know how to prepare and deliver your future presentations. You will be more confident presenting yourself. Thanks to the feedback from your colleagues, the trainer and the video you will be able to identify your strengths and weaknesses.</td>
</tr>
<tr>
<td>363-0427-00L</td>
<td>Business-IT Alignment</td>
<td>W</td>
<td>3</td>
<td>1G</td>
<td>L. Goutas</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Attending the lectures is imperative to complete the assignments.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td></td>
<td>What, how, and outcomes of Business-IT Alignment. This course will introduce tools for strategically aligning business and IT, managing the alignment process, and evaluating the alignment outcomes.</td>
</tr>
<tr>
<td>363-0393-00L</td>
<td>Corporate Strategy</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>S. Ben-Menahem</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Due to didactic considerations, the number of participants for this course is limited to 50. Please register through myStudies to enroll for the course. Slots are assigned on a first-come first-serve basis (in the order of the registration date on myStudies). We will confirm your registration by e-mail. If you have any inquiries about the course, please contact the course assistant.</td>
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</tbody>
</table>

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**Prerequisites / notice**

The course will be supported by the Chair of Entrepreneurial Risks. Please refer to the chair's website for more detailed information regarding the course (www.er.ethz.ch/teaching).
### Abstract
This course focuses on the challenges in managing multi-business corporations, and covers topics related to the vertical and horizontal scope of business activities.

70% of the final grade consists of a final closed-book written exam and 30% of the final grade will consist of individual assignments and group debates.

### Objective
Course Topic and Learning Objectives:
Large- and medium-sized corporations play a central role in the economic activity of most developed and developing countries. Many of these organizations perform multiple business activities in multiple markets. In the face of increasing international competition, globalization, technological development, deregulation, and the emergence of new markets and industries, operating such a portfolio of business activities poses important managerial challenges forcing corporations to continuously re-consider their vertical and horizontal scope and boundaries.

The course Corporate Strategy draws from a wide range of theories and methods to develop an understanding of the conceptual frameworks, debates, and developments concerning decisions associated with the management of multi-business corporations. We will cover the key questions driving a firm's corporate strategy, including:

- In what markets to compete with which businesses?
- Which activities should be performed by the firm and which should be outsourced (i.e. "make" or "buy" decisions)?
- What are the most appropriate approaches to growth and divestiture?
- How do institutional forces impact corporate strategy?

Specifically, we will examine how organizations manage their portfolio of business activities and markets to achieve competitive advantage through vertical integration, cooperative strategies such as strategic alliances and joint ventures, corporate diversification, mergers and acquisitions, diversifications, and globalization/international strategies, and strategic renewal.

### Content
The number of students participating in the lecture is limited to 30.

Format:
The course is a combination of lectures about concepts/methods, guest lectures, case studies/assignments, and group debates.

### Prerequisites / notice
Having participated in the course Strategic Management by Prof. Georg von Krogh/Dr. Zeynep Erden is an advantage but not a requirement.

### Literature
A list with recommended publications will be distributed in the lecture.

Additional Books:
- HBR Collaborating Effectively ISBN 978-1-4221-6264-4
- HBR on Mergers and Acquisitions: ISBN 1-57851-555-6

### Learning outcomes social competence
- Contributing to the learning journey
- Developing structured documentation of interviews
- Writing academic papers
- Developing teamwork skills
- Improving communication skills as basics for collaboration
- Coping with conflicts resolution in teams

### Learning outcomes methodological competence
- Apply tools hands on in real companies (in coll. with companies)
- Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
- Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Realize the value creation potentials of alliances (added value)
- Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Develop structural documentation of interviews
- Developing academic paper
- Contributing to the learning journey

### Learning outcomes academic competence
- Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
- Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Develop structural documentation of interviews
- Writing academic papers
- Developing teamwork skills
- Improving communication skills as basics for collaboration
- Coping with conflicts resolution in teams

### Learning journey:
In an introductory lecture we will give an overview of the theoretical framework and explain the concept of the lecture (Sept. 18, 2014). In weeks 2-5 you will work on a first assignment on six different aspects of the underlying framework: strategy and activities, structure and process, culture and people orientation, interaction and roles, risk and trust, knowledge and learning. This first assignment will give you the basics to participate in the second part (Oct.30-31.2014, 2014) of this seminar. There you will present the results of the first assignment and get additional theoretical input to perform the 2nd assignment. The second assignment will be to analyze real alliance projects in the partner companies. The final lesson will be used as a best practice exchange together with our industrial partners (Dec.18, 2014).

### Prerequisites / notice
The number of students participating in the lecture is limited to 30.
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

Abstract

The slides of the lectures are made available and updated continuously through the SMI website.

Reading assignments: please consult the SMI website:

For further information, please visit: http://www.timgroup.ethz.ch/education/Courses_at_TIMGROUP

Industrial Engineering and Management Methodology


Contact: Balint Dioszegi, bdioszegi@ethz.ch (D-MTEC)

Contact: Balint Dioszegi, bdioszegi@ethz.ch (D-MTEC)

Contact: Balint Dioszegi, bdioszegi@ethz.ch (D-MTEC)

Contact: Balint Dioszegi, bdioszegi@ethz.ch (D-MTEC)
Objective
The objective of this course is to provide students with a practical toolset of techniques, procedures and hints for a successful scientific thesis (Bachelor/Master/MAS Thesis) in industry. The course is held by assistants of professorships at D-MTEC.

Content
Methodology: Systems Engineering, problem solving process, situation analysis, SWOT, objectives, solution finding, evaluation.
Social science methods for empirical data collection and analysis: how to develop a good research question: methodological awareness and practical considerations, criteria in social research: reliability and validity.
Research Designs and Strategies: qualitative and quantitative research.
Methods for data collection and analysis: observation, interview, questionnaire, document and literature analysis, and combinations.

Project Management: tasks plan, milestones, roles, communication
Scientific work: research, resources, citation, argumentation
Presentation: techniques, procedure, handouts, significance

Final report: organization, layout, figures, formal requirements, appendix

Further reading:
http://www.timgroup.ethz.ch/education/Courses_at_TIMGROUP

Lecture notes
Handouts of the presentations / course materials have to be downloaded and printed out before the course (see link above).

Literature

Prerequisites / notice
The course is intended for students who want to carry out a thesis in industry, in general these are:
(1) MSc-students MTEC or MAVT with master thesis (MA) during the next term and supervised by MTEC, (corresponds to 3rd or 4th semester Master) and
(2) BSc-students MAVT with bachelor thesis (BA) in industry and supervised by MTEC, as well as with full MTEC focus (corresponds to 5th or 6th semester Bachelor) or
(3) MAS MTEC students in 3rd semester for MA during the next term.

Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering. 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.

Other students on request (limited places).

Important: the chair coaching your BA/MA defines whether the course is mandatory. Please contact your chair!

Electronic enrollment until 08.09.2015 required. Without electronic enrollment participation in the course can't be confirmed. The course is held "en bloc" at the beginning of the semester.

Date: Friday 11.09.2015 (13:15-17:00), location: HG E33.1 (ETH main building) and Saturday, 12.09.2015 (09:15-17:00), location: HG E33.1 (ETH main building). Participation at both days required (Friday afternoon and Saturday whole day).

The course is held in English; handouts are available in English.

Besonderes (deutsche Version):
Der Kurs richtet sich an Studierende, welche an einer Professor des D-MTEC eine Arbeit in der Wirtschaft schreiben werden. Im Allgemeinen sind dies:
(1) MSc-Studierende MTEC oder MAVT mit Masterarbeit (MA) im kommenden Semester, die vom MTEC betreut wird, (entspricht 3. oder 4. Semester Master) sowie
(2) BSc-Studierende MAVT mit Bachelorarbeit (BA) in der Wirtschaft, die vom MTEC betreut wird, sowie mit vollem MTEC Fokus (entspricht 5. oder 6. Semester Bachelor) oder
(3) MAS MTEC -Studierende im 3. Semester für MA im kommenden Semester.


Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).

Wichtig: die Professor, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!

Elektronische Einschreibung bis zum 08.09.2015 notwendig. Ohne elektronische Einschreibung kann Ihre Teilnahme am Kurs nicht bestätigt werden.

Der Kurs wird als Blockkurs zu Beginn des Semesters gehalten.

Termin: Freitag, den 11.09.2015 (13:15-17:00) im HG E33.1 und Samstag, 12.09.2015 (09:15- ca. 17:00) im HG E33.1 (ETH Hauptgebäude). Anwesenheitspflicht an beiden Tagen (Freitagabend und Samstag ganztags).

Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.
Abstract
Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.
This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

Objective
This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of does and don'ts is provided through highlighting and discussing real life examples and cases.

Content
See course website

Lecture notes
Lecture slides and case material

851-0609-05L The Economics of Climate Change

Abstract
Climate change is one of the most pressing issues that governments and the global community have to face. This course outlines the problem of climate change and discusses the economic solutions (both domestic and international) to this problem.

Objective
This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic solutions to combating climate change (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.

Content
Economics of pollution, Optimal level of greenhouse gases, International Environmental Agreements, Tradable pollution permit markets, Carbon Taxes, Technological innovation and R&D, The optimal approach to control Climate change, The future of Climate change policy

Literature
Also, Journal articles will be cited

Prerequisites / notice
Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore, prior knowledge is recommended.

363-0887-00L Management Research (Basics of Scientific Work)

Abstract
The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation.
Participation to both sessions are mandatory to receive the credit, there will be no exceptions.
If a student can't take part in one of the sessions, the course has to be taken the following semester.

Objective
This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.

Content
This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.

Literature
Nicola Siggelkow (2007) Persuasion with Case Study AMJ Vol. 50, No. 1

Prerequisites / notice
The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation - those will be served first.
· The course will be given once every semester by Dr. Zeynep Erden Özkol and the PhD students of the chair.
· The course takes two days, one for lecture, one for student paper presentations. Participation to both sessions are mandatory to receive the credit, there will be no exceptions.
· Students who participate in the lecture and present a paper receive 1 credit point. The course and the presentations will be given in English.
· Students might benefit more if they take this course towards the end of their studies, before writing their master thesis.

363-0445-02L Logistics, Operations, and Supply Chain Management

Abstract
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Objective
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

363-0622-00L Basic Management Skills

Limited number of participants.
Mandatory registration by 3.8.2015 via the administration
To convey management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).

Abstract

With the aim of preparing the students to take on managerial responsibility, this 2x5 days-seminar teaches basic and practical management skills.

Objective

To convey management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).

Content

1 Fundamentals of Communication Psychology
2 Communication in Business-Life
3 Fundamentals of Leadership
4 Self-Management and Life Balance
5 Leadership Tools
6 Problem Solving and Decision Making Techniques
7 Performance Coaching
8 Conflict Management
9 Personality
10 Summary-Day, Domino-Examination

Lecture notes

Will be provided as electronic version at www.entrepreneurship.ethz.ch at least one week before the seminar starts

Prerequisites / notice

Special permission from lecturers required
10 days in two weeks, 09:00-17:00

The number of participants is limited. Please send an email to bms@ethz.ch by 03.08.15 for your registration

Week I: 17.08.15 to 21.08.15
Week II: 07.09.15 to 11.09.15

<table>
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<th>Code</th>
<th>Title</th>
<th>Weeks</th>
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<tr>
<td>365-1019-00L</td>
<td>Human Resource Management: Skills in Practice</td>
<td></td>
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<td>M. Gubler, M. Kolbe</td>
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<tr>
<td>365-1028-00L</td>
<td>Entrepreneurial Leadership</td>
<td></td>
<td>4</td>
<td>S</td>
<td>C. P. Siegenthaler, P. Baschera, S. Brusoni, G. Grote, V. Hoffmann, G. von Krogh</td>
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<tr>
<td>365-1021-00L</td>
<td>Monetary Policy</td>
<td></td>
<td>3</td>
<td>V</td>
<td>J.E. Sturm, D. Kaufmann</td>
</tr>
</tbody>
</table>
Exclusively for MAS MTEC students (first semester).
The online course will be open from 14.09.2015 to
14.02.2016. Within this time, students can proceed
through the course at their own convenience. Seat time is
about 25 hours.

All MAS MTEC students will receive further information by
e-mail on 14.09.2015.

Abstract
This course is a web-based, online, interactive introduction to financial accounting within the context of management requirements. It has been developed by Harvard Business Publishing.

Objective
The online course uses the case study "Global Grocer" to guide the students from company foundation with a simple balance sheet towards more complex balance sheets, income and cash flow statements. This ensures an integrated understanding of company transactions.

Content
1. Introductory Section
   1.1 Terms and Concepts
   1.2 The Balance Sheet
   1.3 Income Statement
   1.4 Accounting Records
   1.5 The Statement of Cash Flows
2. Advanced Section
   2.1 Revenue & Receivables
   2.2 Inventories and Cost of Sales
   2.3 Depreciation and non-current Assets
   2.4 Liabilities and Financing Costs
   2.5 Investment & Investment Income
   2.6 Deferred Taxes and Tax Expense
   2.7 Owner's Equity

Lecture notes
The Financial Accounting online-course is an ideal complement to the lectures "Accounting for Managers (363-0711-00)" as well as "Financial Management (363-0560-00)" with the purpose to further deepen the student's knowledge of accounting. Parts of the course content are overlapping, however, it is provided in a different context. Not covered in the online course is managerial accounting which is an important topic in the lecture "Accounting for Managers".

Literature
Needles & Powers (2010), Financial Accounting, 11e, South-Western College Pub

Prerequisites / notice
The online course will be open from 14.09.2015 to 14.02.2016. Within this time, students can proceed through the course at their own convenience. Seat time is about 25 hours. The online course should be accessed and activated only if students wish to take and complete it.

No lectures are offered for this course. Specific course topics can be discussed with other course participants, and any questions regarding the course content will be answered by an expert on the learning platform Moodle.

363-1044-00L Applied Negotiation Seminar
Due to didactics reasons, the number of participants is limited to 30.

W 3 credits 2S M. Ambühl

Prerequisites: Successful completion of lectures "363-1039-00L Introduction to Negotiation".

Abstract
The block-seminar combines lectures introducing negotiation, negotiation engineering and specific aspects of successful negotiation with the respective application through in-class negotiation case studies and games.

Objective
Students obtain a concentrated insight into key aspects of the field of negotiations, negotiation engineering and specific aspects of successful negotiation. Multiple opportunities to apply that knowledge in different negotiation situations allow for an in-depth learning experience.

365-1035-00L Quality Management
Exclusively for MAS MTEC students (third semester).

Limited number of participants: a minimum of 10 persons and a maximum of 30 persons.

Please register by 16.09.2015 at the latest via myStudies.

W 3 credits 2S A. Kach

Attendance on the first course day is highly recommended.

Abstract
The design of this course is intended to introduce quality management from an operations and manufacturing viewpoint. Many of the key topics covered throughout the course can be located in the Content section below.

Objective
This course will provide students with the underlying principles and techniques surrounding Quality Management with an emphasis on the application in manufacturing and services settings. Students will develop a working knowledge of the best practices in Quality and Process Management. Students will learn to view quality from a variety of functional perspectives and in the process, gain a better understanding of the problems associated with improving quality. The course aims to impart knowledge on the quality management process and key quality management activities. Specifically it aims to: Compare and contrast the various tools used in quality management, comprehend the concepts of customer's value, discuss the emerging tendencies toward global competitiveness, understand different perspectives on quality, explore six-sigma management and its tools, demonstrate how to design quality into product and services, describe the importance of developing a strategic plan for Quality Management, and discuss the importance of 'benchmarking' as a means of identifying the choice of markets.
Content  Major Topics:
Total Quality Management (TQM): Excellence in manufacturing/service, factors of excellence, applications of TQM
Process Management: Quality function development (QFD) and quality assurance systems, factors affecting process management
Benchmarking Procedures
Statistical Process Control (SPC) and failure mode and effect analysis (FMEA) procedures
Demming's 14 points of Management
Continuous Improvement
Supplier Evaluation: Managing Supplier Quality
Manufacturing capabilities: Quality as a core focus, cost management, competencies
Environmental Factors: Turbulent environments, manufacturing intensity, uncertainty
Quality Systems Certification Policy:
Six Sigma
ISO 9001, 9002, 9003 / ISO 14001 (Environmental quality policies)

Literature
Readings:
Required:
Recommended:

363-1049-00L Contemporary Conflict Management W 3 credits 2V M. Ambühl
Abstract The course provides students with theoretical background and practical insights in conflict management in the 3 areas international, business and interpersonal (legal) relations. Students are introduced into theoretical concepts related to the research field and real world case studies including examples of international conflicts, WWI, old and new regional conflicts, business and mediation.
Objective Students will gain
- knowledge of history of conflict management;
- comprehension of major ideas in the theory and practice of conflict management, mediation, transformation and resolution;
- application of theoretical concepts to current conflict situations;
- evaluation of conflict situations in international relations and business.
Content The following topics will be covered:
- history of international and regional conflicts;
- theoretical concepts of conflict management;
- theoretical models of arms races and conflict escalation;
- case studies in international conflicts, as well as in business.
Distinguished guest speakers will be invited.

Literature
- Peter Wallensteen (2012): Understanding Conflict Resolution. SAGE, London, UK
- Philip D. Straffin (1993): Game theory and strategy, Mathematical Association of America, Washington, DC.

365-1067-00L (Un)ethical Decision Making: Alternative and Critical Thinking in Management
Exclusively for MAS MTEC students (third semester).
Limited number of participants: a minimum of 10 persons and a maximum of 40 persons.
Abstract This course is about decision making processes in complex situations involving financial, relational and ethical problems. First, it provides fundamental tools for addressing problematic situations. Second, it discusses how stakeholders’ ethical expectations and social responsibility issues can be effectively implemented and integrated in organizational systems and strategic planning processes.
Objective
- Become familiar with tools and procedures to prevent, identify and resolve corporate fraud and crime in organizations
- Understanding the mutual relationship between financial, relational and ethical drivers in managerial decision making
- Become familiar with tools and procedures to prevent and resolve corporate crises and scandals
- Understanding the opportunities associated with the corporate social responsibility (CSR) movement and how to integrate CSR in organizational and strategic planning
- Create an effective CSR strategic planning process to successfully develop and implement a CSR package
- Understand a variety of strategic CSR planning tools
- Become familiar with creating deep destructive change in pursuit of dual economic and social value

Content
- Fraud and corruption in organizations
- Crisis management
- Personnel problems: Preventing and managing mobbing and sexual harassment
- Global criminal networks

Lecture notes
Most classes are taught through a series of mini-cases and notes that represent real management decisions.
Some classes are complemented with readings from prominent media resources, guest speakers and experimental exercises.
This course is based on mini-cases that will be distributed during the classes.

Moodle of the course: https://moodle-app2.let.ethz.ch/course/view.php?id=1425

Prerequisites / notice
No Pre-course preparation as requirement.
This is an interactive course.

## Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>365-0899-00L</td>
<td>Master's Thesis in a Company</td>
<td>O</td>
<td>12 credits</td>
<td>24D</td>
<td>Professors</td>
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</table>

Exclusively for MAS MTEC students.

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and is performed within a private company.

Objective
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and is performed within a private company.

MAS in Management, Technology, and Economics - Key for Type

- **O**: Compulsory
- **W+**: Eligible for credits and recommended
- **W**: Eligible for credits

- **E-**: Recommended, not eligible for credits
- **Z**: Courses outside the curriculum
- **Dr**: Suitable for doctorate

Key for Hours

- **V**: lecture
- **G**: lecture with exercise
- **U**: exercise
- **S**: seminar
- **K**: colloquium

- **P**: practical/laboratory course
- **A**: independent project
- **D**: diploma thesis
- **R**: revision course / private study

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
By the end of this course the participants will be able to:

The purpose of this course is to impart basic knowledge in radiobiology in order to handle ionizing radiation and to provide a basis for

Biostatistics

Abstract

The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, analysis of variance, logistic regression, survival analysis (Kaplan-Meier curves and Cox-regression).

Content

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes

Lecture notes and handouts

Literature

Webb A, Smith N.B. Introduction to Medical Imaging; Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

Biomedical Imaging

Abstract

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content

- Ultrasound/Doppler imaging
- Magnetic resonance imaging
- Positron emission tomography
- Single photon emission tomography
- Computed tomography
- X-ray imaging

Lecture notes

Lecture notes and handouts

Literature

Prerequisites / notice

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

Radiobiology

Abstract

The purpose of this course is to impart basic knowledge in radiobiology in order to handle ionizing radiation and to provide a basis for predicting the radiation risk.

Objective

By the end of this course the participants will be able to:

- understand different treatment responses of the tumor and the normal tissue to differential clinical-related parameters of radiotherapy (dose rate, LET etc.).
- understand differences in the radiation response of normal tissue versus tumor tissue
- understand different treatment responses of the tumor and the normal tissue to differential clinical-related parameters of radiotherapy
- understand factors which underpin the differing radiosensitivities of different tumors
- develop rational strategies for combined treatment modalities of ionizing radiation with targeted agents
- interpret the 5 Rs of radiation oncology in the context of the hallmarks of cancer
- predict the radiation risk.

Content

Einführung in die Strahlenbiologie ionisierender Strahlen: Allgemeine Grundlagen und Begriffsbildung; Mechanismen der biologischen Strahlenwirkung; Strahlenwirkung auf Zellen, Gewebe und Organe; Modifikation der biologischen Strahlenwirkung; Strahlenzytogenetik: Chromosomenveränderungen, DNA-Defekte, Reparaturprozesse; Molekulare Strahlenbiologie: Bedeutung inter- und intrazellulärer Signalübermittlungsprozesse, Apoptose, Zellzyklus-Checkpoints; Strahlensirio; Strahlensyndrome, Krebsinduktion, Mutationssauslösende, pränatale Strahlenwirkung; Strahlenbiologische Grundlagen des Strahlenschutzes; Nutzen-Risiko-Abwägungen bei der medizinischen Strahlenanwendung; Prädiktive strahlenbiologische Methoden zur Optimierung der therapeutischen Strahlenanwendung.

Lecture notes

Beilagen mit zusammenfassenden Texten, Tabellen, Bild- und Grafikdarstellungen werden abgebegangen

Literature

Literaturliste wird abgegeben.


Prerequisites / notice

The former number of this course unit is 465-0951-00L.
Physics in Medical Research: From Atoms to Cells

Abstract
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Objective
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefit of patients and the society.

Content
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will be further elaborated. The student will get an understanding of the characteristic of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Lecture notes
A script will be provided.

402-0674-00L

Physics in Medical Research: From Atoms to Cells

Abstract
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

Objective
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocline behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size of the nanostructures. The nucleation rate is given by the rates of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructures' shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

465-0956-00L

Dosimetry

Abstract
Dosimetry in radiotherapy. Planning and implementation of a percutaneous radiation exposure on an anthropomorphic phantom.

Objective
Praktische Umsetzung der Lerninhalte der Vorlesungen Medizinphysik I & II bezüglich Dosimetrie bei perkutanen Strahlenexpositionen

Content
Dosimetrie in der Strahlentherapie. Planung und Durchführung einer perkutanen Strahlenexposition an einem anthropomorphen Phantom.

Lecture notes
Die Kursunterlagen werden im Blockkurs abgegeben.

465-0957-00L

Physiology and Anatomy for Medical Physicists I

Abstract
Introduction into the functions and structural properties of tissues, organs, systems of organs and the human body as an organism.

Objective
Grundlagen in Physiologie und Anatomie des menschlichen Körpers sowie Kenntnis und korrekte Anwendung der medizinischen Fachsprache

Content
"Physiology and Anatomy for Medical Physicists I & II" provides an introduction into the functions and structural properties of tissues, organs, systems of organs and the human body as an organism. The major part of the course is dedicated to the most important systems of organs. Anatomy and physiology are discussed integrated in the thematical order. Each topic is preceded by some comments concerning evolution and/or embryology. The content of the lessons is adapted to engineers and an emphasis is set to medical terminology. In a supplementary part of the course a few topics in applied physiology will be presented.

465-0953-00L

Biostatistics

Abstract
The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, analysis of variance, logistic regression, survival analysis (Kaplan-Meier curves and Cox-regression).

465-0966-00L

Physics in Radiodiagnostic and Nuclear Medicine

Abstract
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Objective
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefit of patients and the society.

Content
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will be further elaborated. The student will get an understanding of the characteristic of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Lecture notes
A script will be provided.
Abstract
The course is dedicated to introduce MAS students from Medical Physics to the field of radiodiagnostics and nuclear medicine. Dedicated practicals will illustrate the theory with an emphasis on the relationship between dose and image quality as well as the security problems related to the work with radiations.

Objective
This 1-week theory and practical class offers the possibility to enjoy a variety of research and clinical areas in diagnostic and nuclear medicine. It gives insight into practical concepts and techniques that are discussed thoroughly as the class is performed within actual laboratories with real radiation sources.

Content
The course starts with the physical basis of radiography (from X-ray production to image detectors) and continues with the basic parameters of image quality in radiography (contrast, resolution, noise) and their measurement methods. Specific applications of radiation diagnostic are then considered separately.

Biomolecular Structure and Mechanism I: Protein Structure and Function
D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course

Abstract
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Objective
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microarrays.

Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Literature
Basic:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

551-0307-00L

529-0004-00L

Computer Simulation in Chemistry, Biology and Physics

Abstract
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Objective
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes
Available (copies of powerpoint slides distributed before each lecture)

Literature
See: www.csms.ethz.ch/education/CSCBP

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

227-0385-10L

Biomedical Imaging

Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

227-0386-00L

Biomedical Engineering

Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 874 of 1432
**Introduction into Bioengineering**

Lecture notes

By Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

---

### 227-1037-00L Introduction to Neuroinformatics

**W 6 credits 2V+1U**

**K. A. Martin, M. Cook, V. Mante, M. Pfeiffer**

**Abstract**

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

**Objective**

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocolures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

**Content**

This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

**Literature**

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocolures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

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### 376-1651-00L Clinical and Movement Biomechanics

**W 4 credits 3G**

**S. Lorenzetti, R. List, N. Singh**

**Abstract**

Measurement and modeling of the human movement during daily activities and in a clinical environment.

**Objective**

The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

**Content**

This course includes ethical considerations, measurement techniques, clinical testing, accessing movement data and anisys as well as modeling with regards to human movement.

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### 376-1714-00L Biocompatible Materials

**W 4 credits 3G**

**K. Maniura, J. Möller, M. Zenobi-Wong**

**Abstract**

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

**Objective**

The class consists of three parts:

1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

**Content**

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

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### 402-0674-00L Physics in Medical Research: From Atoms to Cells

**W 6 credits 2V+1U**

**B. K. R. Müller**

**Abstract**

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

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**Handouts can be accessed online.**

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**Literature**


(available online via ETH library)

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**Handouts provided during the classes and references therein.**
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultraviolet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

### 376-1791-00L Introductory Course in Neuroscience I

<table>
<thead>
<tr>
<th>Objective</th>
<th>The course gives an introduction to the development and anatomical structure of nervous systems. Furthermore, it discusses the basics of cellular neurophysiology and neuropharmacology. Finally, the nervous system is described on a system level with a particular emphasis on the visual system.</th>
</tr>
</thead>
</table>
| Content | 1) Neuroanatomy I  
2) Neuroanatomy II  
3) Neurogenesis  
4) Axon guidance  
5) Action and language development  
6) Circadian rhythms  
7) Synaptic plasticity  
8) Synaptic transmission  
9) Neural circuits in vivo  
10) Visual pathways and visual processing  
11) Somatosensory system  
12) Vestibular system  
13) Sleep  
14) Learning and Memory, mice and human |
| Prerequisites / notice | For doctoral students of the Neuroscience Center Zurich (ZNZ). |

### 376-1795-00L Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain)

<table>
<thead>
<tr>
<th>Objective</th>
<th>The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites / notice</td>
<td>Für Doktorierende des Zentrums für Neurowissenschaften Zürich. Nicht für Master-Studierende geeignet.</td>
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</tbody>
</table>

### 227-0980-00L Seminar on Biomedical Magnetic Resonance

<table>
<thead>
<tr>
<th>Objective</th>
<th>Actual developments and problems of magnetic resonance imaging (MRI)</th>
</tr>
</thead>
</table>

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**MAS in Medical Physics - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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</tbody>
</table>
### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

ECTS  
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Spatial Planning

Lectures and Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>115-0300-00L</td>
<td>Preliminary Course: Introduction to Swiss Spatial Planning</td>
<td>Only for MAS, DAS and CAS in Spatial Planning</td>
<td>3 credits</td>
<td>3G</td>
<td>L. Bühlmann, A. Schneider</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Tasks of spatial planning; objectives and principles; instruments of spatial planning; federal planning; cantonal structural planning; constructing outside of building zones; communal planning; land use planning; compensation of benefits released by planning; environmental protection and spatial planning; review of the spatial planning act; case studies and exercises.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The preliminary course introduces students to the fundamentals of formal spatial planning in Switzerland. It gives a first overview over background and context of spatial planning as well as instruments of spatial planning.</td>
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<tr>
<td>115-0341-00L</td>
<td>Lecture Week 01: Introduction to the Programme</td>
<td>W</td>
<td>2 credits</td>
<td>1G</td>
<td>A. Grams Dietziker</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Discussion of the individual basic understanding of spatial planning; Personal preconditions for and expectations of MAS-program; program concept; knowledge portfolio and learning contract; work environments and tools; introduction to study project 1 with excursion; theoretical background for interdisciplinary team work and spatial design.</td>
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<td><strong>Objective</strong></td>
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<td>Aim of the first week is, to give participants a first overview over the programme and the first study project, to clarify the above mentioned topics of the individual positions and expectations towards the course as well as to acquire basic knowledge about teamwork and design.</td>
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<tr>
<td>115-0303-00L</td>
<td>Lecture Week 02: Spatial Planning: Function and Methods</td>
<td>W</td>
<td>2 credits</td>
<td>1G</td>
<td>B. Scholl</td>
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<td><strong>Abstract</strong></td>
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<td>Significant tasks for spatial development in the future involve the internal development of existing areas, the development of integrated solutions in cross-cutting areas of housing, transportation, and landscape as well as addressing transboundary tasks in the context of european and global perspectives; fundamental methods in spatial planning for exploring, clarifying and solving spatial tasks.</td>
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<td><strong>Objective</strong></td>
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<td>Aim of the course unit is the acquaintance and the comprehension of important tasks and principles in spatial planning; important methodical modules like assessment of the situation, concentration on important tasks as well as designing, decision-making and arguing are providing also a base for working on both study projects of the MAS programme.</td>
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<tr>
<td>115-0315-00L</td>
<td>Lecture Week 03: Urban Planning and Urban Design I</td>
<td>Only for MAS, DAS and CAS in Spatial Planning</td>
<td>2 credits</td>
<td>1G</td>
<td>K. Christiaanse, S. Kretz</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Modern urban phenomena and their application to urban design as methods and tools. Lectures are accompanied by design exercises. They are used to project desirable futures and at the same time, they are thought experiments that investigate the qualities of the present reality.</td>
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<td></td>
<td>Introduction in current problems and methods of urban design; insights in current tasks, discussions, projects and basic definitions of city, urban design and urban planning.</td>
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<td>115-0337-00L</td>
<td>Lecture Week 04: Landscape Architecture</td>
<td>Only for MAS, DAS and CAS in Spatial Planning</td>
<td>2 credits</td>
<td>1G</td>
<td>C. Girot, P. C. Fricker</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Information technology and its possibilities for the integration in design; drawing, model and video camera for application in methods for analysis, design and visualisation; recording and visualisation of landscape with geobased data; topology; the regulating power of landscape architecture for the current requirements on the ambient space.</td>
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<td><strong>Objective</strong></td>
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<td>Introduction in theory and methods of landscape architecture; illustration of a landscaping approach in urban planning; critical examination and reflection about landscape and tools as well as the objectives of its designers; providing fundamentals for a reflected understanding of design.</td>
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<tr>
<td>115-0339-00L</td>
<td>Lecture Week 05: Landscape and Environmental Planning</td>
<td>Only for MAS, DAS and CAS in Spatial Planning</td>
<td>2 credits</td>
<td>1G</td>
<td>A. Grêt-Regamey</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Discussion of the proposition of sustainability in landscape and environmental planning; comprehending landscape development with a system dynamics approach; planning of landscape development across cantonal and communal boundaries; negotiating various stakeholder interests on the example of watercourse corridors; instruments and approaches for sustainable development of urban landscapes.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Overview of tasks of landscape and environmental planning as well as essential theories; insights in planning approaches and application of new instruments related to current problems for a sustainable landscape development.</td>
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</tbody>
</table>

Projects and Individual Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>115-0355-00L</td>
<td>Study Project 1 (Part 1)</td>
<td>Only for MAS in Spatial Planning</td>
<td>0 credits</td>
<td>9U</td>
<td>M. Werren, F. Günther, D. L. Kolb, P. J. Noser, R. Tremp</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Project 1 takes 2 semesters, continuation in the following spring semester, taking part 2 is obligatory. Development of strategies for sustainable development in the City of Berne: spatial planning analysis of the situation (goals and problems, potentials and risks, strengths and weaknesses); concept design (goals and measures); program development (objective and temporal priorities); preparation for implementation (instruments and procedures), independent group work.</td>
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<td></td>
<td><strong>Objective</strong></td>
<td></td>
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<tr>
<td></td>
<td>Detect, assess and classify the main conflicts of spatial developments and detect need for planning action. Concentrate resources and design and evaluate different solutions and demonstrate their feasibility exemplarily. Recognize possibilities and limits of formal and informal planning and applying them practically. Efficient and interdisciplinary work in groups, using individual knowledge and skills of group members optimally.</td>
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MAS in Spatial Planning - Key for Type

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

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>ECTS</th>
<th>European Credit Transfer and Accumulation System</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td></td>
<td>Special students and auditors need special permission from the lecturers.</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td></td>
<td></td>
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<tr>
<td>U</td>
<td>exercise</td>
<td></td>
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<tr>
<td>S</td>
<td>seminar</td>
<td></td>
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<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
<td></td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<td></td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>
MAS in Sustainable Water Resources

The Master of Advanced Studies in Sustainable Water Resources is a 12 month full time postgraduate diploma programme. The focus of the programme is on issues of sustainability and water resources in Latin America, with special attention given to the impacts of development and climate change on water resources. The programme combines multidisciplinary coursework with high level research. Sample research topics include: water quality, water quantity, water for agriculture, water for the environment, adaptation to climate change, and integrated water resource management.

Language: English. Credit hours: 66 ECTS.

For further information please visit: http://www.ifu.ethz.ch/MAS_SWR

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>118-0101-00L</td>
<td>Water Resources Seminars</td>
<td>O</td>
<td>3 credits</td>
<td>3S</td>
<td>P. Molnar, P. Burlando, further speakers</td>
</tr>
<tr>
<td>102-0287-00L</td>
<td>Fluvial Systems</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Molnar</td>
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<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando, S. Fatiachi</td>
</tr>
<tr>
<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Holzner</td>
</tr>
<tr>
<td>103-0237-00L</td>
<td>GIS III</td>
<td>O</td>
<td>5 credits</td>
<td>3G</td>
<td>P. Kiefer, S. Schneider</td>
</tr>
<tr>
<td>102-0227-00L</td>
<td>Systems Analysis and Mathematical Modeling in</td>
<td>O</td>
<td>6 credits</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
</tr>
</tbody>
</table>

Course Objectives

- Develop understanding of numerical simulation of flows to an extent that they can later use commercially available software in a responsible and critical way.
- Learn to specific case studies.
- Study materials (lecture handouts and selected papers) are distributed in class and available on the web.
- Additional literature is presented during the course.

Prerequisites

- Hydrology 1 and Hydrology 2 (or contact instructor).

Course Content

- The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.
- The goal of the course is to develop numerical models for water resources and water resource management.
- The course presents an integrated view of the river basin and fluvial system. The fluvial system is viewed in terms of the dynamics in the transfer of water and sediment, the resulting geomorphology of the river network and streams, and finally the basin and river management options for conservation and restoration.
- The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English, and the students will be exposed to water related topics in international settings.
- The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Course Literature

- Web Services: technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS.

Course Prerequisites

- Hydrology 1 and Hydrology 2 (or contact instructor).
- Study materials (lecture handouts and selected papers) are distributed in class and available on the web.
- Additional literature is presented during the course.

Course Resources

- For further information, contact the MAS coordinator, Darcy Molnar (darcy.molnar@ifu.baug.ethz.ch)

Urban Water Management
This course supports the course in Biological Wastewater Treatment (102-0217-00L). It is therefore advantageous to follow both courses simultaneously.

Abstract

Objective
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

Content
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Lecture notes
Copies of overheads will be made available.

Literature
Selected scientific articles & book chapters

Prerequisites / notice
This course will be offered together with the course Process Engineering I. It is advantageous to follow both courses simultaneously.

701-1551-00L Sustainability Assessment
3 credits

Objective
At the end of the course the students should:

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

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

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

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

102-0217-00L Process Engineering I (Biological Processes)
3 credits

Objective
This course will be combined with Systems Analysis and Mathematical Modeling (102-0227-00L). It is therefore advantageous to follow both courses simultaneously.

Abstract
Introduction of kinetic models for activated sludge systems and biological nutrient removal as a basis for design and dynamic simulation:
- Nitrification, denitrification, biological phosphorus removal (ASM1 to ASM3). Kinetics of biofilms, application to full scale reactors.
- Anaerobic treatment schemes, industrial waste, biogas production, sludge handling. Aerobic thermophilic processes.

Content
The goal of this unit is to provide the background for the understanding, design and simulation of today's biological wastewater treatment and sludge stabilization processes. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.
- Microbial transformation processes
- Introduction to the activated sludge process
- Modeling activated sludge systems
- Nitrification / denitrification / biological P elimination
- Enrichment, selectors, filamentous growth
- Biofilm kinetics and application to full scale plants
- Anaerobic processes, industrial applications, sludge stabilization
- Aerobic thermophilic processes

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase:

Prerequisites / notice
This course will be offered together with the course Systems Analysis and Mathematical Modeling. It is advantageous to follow both courses simultaneously. For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling (102-0227-00L), it is therefore advantagous to follow both courses simultaneously.

651-4031-00L Geographic Information Systems
3 credits

Abstract
Number of participants limited to 60.

Objective
Introduction to the architecture and data processing capabilities of geographic information systems (GIS). Practical application of spatial data modeling and geoprocessing functions to a selected project from the earth sciences.

Content
Knowledge of the basic architecture and spatial data handling capabilities of geographic information systems.

Lecture notes
Introduction to Geographic Information Systems, Tutorial: Introduction to ArcGIS Desktop
### Implementation of Environmental and other Sustainability Goals

#### Abstract
How to make sustainability operational - in industry, services and other organizations: You will learn how to put sustainability into practice by integrating environmental, social and economic aspects into organisations' management and processes. The course contains both a management view, as well as a sustainability view - and how to combine them.

#### Objective
To provide understanding of how sustainability can be made operational in an organisation. To do so, students will understand how to integrate sustainability thinking into the typical current organisational environment and processes, such as planning, implementing and controlling.

#### Content
We meet for five 3-hour-lectures, with discussions and case studies during course time. Additionally, small case studies in-between courses will be given at most course days.

Course topics are:
- Sustainable Development and its meaning for Management
- Management Standards for Sustainability (ISO and others)
- Sustainability Opportunities and Innovation
- Organisation and Implementation
- The concept of 'Continuous Improvement'
- Environmental Performance Measurement (Concepts, Standards, Methods)
- Life Cycle Costing, Life Cycle Management
- (Sustainable) Supply Chain Management
- Communication of Sustainability Issues

Lecture notes
Course documentation as well as case study descriptions will be provided during the course via the "illias" repository.

Literature
There are two ways to approach the course's issues:


c) We will touch upon the hotel sustainable scheme and label "Ibex" see: http://www.e2mc.com/images/stories/e2_bilder/downloads/Umweltfocus_d.pdf (for an english version, pls contact the lecturer at arthurb@ethz.ch).

Prerequisites / notice
If you have specific interests or questions, let me know at arthurb@ethz.ch. Maybe I can include your issues - or I can't :-)

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**Data: 06.12.2018 13:04**

**Autumn Semester 2015**

**Page 882 of 1432**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The course provides the first part of an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects. The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio. www.rstudio.org

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Lecture notes
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

Prerequisites / notice
The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145
Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)

W 3 credits 1V
University lecturers

Objective
Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

Content
Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Literature
Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.

Prerequisites / notice
Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes

Water Resources and Drinking Water

W 3 credits 2G
S. Hug, M. Berg, F. Hammes, U. von Gunten

Objective
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore, legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally, unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Analysis of Climate and Weather Data

W 3 credits 2G
C. Frei

Objective
Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

Content
Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology. Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

The lecture also provides an introduction into R, a programming language and graphics tool frequently used for data analysis in meteorology and climatology. During hands-on computer exercises the student will become familiar with the practical application of the methods.

All material is made available via the lecture web-page.
The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

**Objective**

The students can understand the role of land processes and associated feedbacks for the climate system.

**Lecture notes**

Powerpoint slides will be made available

**Prerequisites / notice**

Suggested literature:


**Literature**

Prerequisites: Atmopherie, Mathematik IV: Statistik, Anwendungshafnes Programmieren.

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**651-4101-00L Physics of Glaciers**

**Abstract**

Application of basic physical concepts to glaciers and ice caps. Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.

**Objective**

The course outlines the physical principles governing the gravity-driven motion of glacier ice. This is applied to understand the response of glaciers and ice sheets to changes in their environment. Polar ice caps, ice streams and mountain glaciers and their recent rapid changes are discussed.

**Content**

The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

**Prerequisites / notice**

Climate systems -> http://www.vwz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?lerneinheitId=61924&semkez=2009W&lang=en and/or

**Lecture notes**

http://people.ee.ethz.ch/~luethim/teaching.html

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**701-1251-00L Land-Climate Interactions**

**Abstract**

The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

**Objective**

The students can understand the role of land processes and associated feedbacks for the climate system.

**Lecture notes**

Powerpoint slides will be made available

**Prerequisites / notice**

Suggested literature:


**Literature**

Prerequisites: Atmopherie, Mathematik IV: Statistik, Anwendungshafnes Programmieren.

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**701-1437-00L Limnecology**

**Abstract**

This course combines Limnology (the study of inland waters in its broad sense) with Ecological and Evolutionary concepts. It deals with rivers, groundwater and lakes. This course contains a lecture part, an experimental part as well as 1-day excursions.

**Objective**

During this course you will get an overview of the world's typical freshwater ecosystems. After this course you will be able to understand how aquatic organisms have adapted to their habitat, and how the interactions (e.g. food web) between organisms work. During the experimental part of this course you will learn the principles of doing research to observe interrelations in aquatic ecosystems. You will measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge. In short: apply the theoretical / lecture knowledge to field situations in a lake and river.

**Content**

The lecture part covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwaters. Applied case studies and experiments testing ecological and evolutionary processes in freshwaters. The lectures are given by Piet Spaak (Eawag), Florian Altermatt (UNI, Eawag), Tom Gonser (Eawag), Katja Räsänen (Eawag) and Chris Robinson (Eawag), specialists from the Aquatic Ecology department of Eawag and University of Zurich.

**Practical part:**

During the practical part you will work with survey methods used in research and practice.

**Lecture notes**

Course notes and powerpoint presentations provided during the course.

**Prerequisites / notice**

This course can only be taken together with "701-1437-01 Bestimmungskurs aquatische Makroinvertebraten" and "701-1437-02 Bestimmungskurs aquatische Mikroinvertebraten und Kryptogamen".

The maximal participating number of students is 8 from D-USYS and 14 from D-BIOL (ETH & UNI).

Registration for the course until Thu 10.9.2015, free places will be distributed Fri 11.9.2015.

The course includes a mandatory field trip to the Sense River floodplain. It will take place Saturday, September 26.

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**701-1631-00L Foundations of Ecosystem Management**

**Abstract**

This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

**Objective**

Students should be able to

a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.

b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.
Content

Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasize the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degrading these processes for human welfare and environmental well-being. Building upon this theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Lecture notes

No Script

Literature


701-0727-00L Politics of Environmental Problem Solving in Developing Countries

Objective

After completion of the module, students will be able to:

- Identify and appraise ecological aspects in development cooperation, development policies and developing countries' realities
- Analyze the forces, components and processes, which influence the destiny, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Content

The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology

Abstract

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective

Students are able to

- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection,
- conduct and interpret a limited number of experimental studies,
- explain links between physical processes in the vadose-zone and major societal and environmental challenges.

W. Hajnsek

The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental parameter estimation.

At the end of the course the student has the understanding of SAR basics and principles, SAR polarimetry, SAR interferometry and environmental parameter estimation from multi-parametric SAR data. Environmental Applications

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

Part 1 - Laminar flow in tubes (Poisuelle's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow: unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.


Complete literature listing will be provided during the course.

401-0649-00L

Applied Statistical Regression

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

401-0659-00L

Basics and Principles of Radar Remote Sensing for Environmental Applications

The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

This course in combination with 102-0627-00-G: Applied Radar Remote Sensing for Environmental Parameter Estimation is providing a profound basis for independent data analysis. It is recommended to take both courses together.
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Lecture notes
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

701-1644-00L Mountain Forest Hydrology

Abstract
This course presents a process-based view of the hydrology, biogeochemistry, and geomorphology of mountain streams. Students learn how to integrate process knowledge, data, and models to understand how landscapes regulate the fluxes of water, sediment, nutrients, and pollutants in streams, and to anticipate how streams will respond to changes in land use, atmospheric deposition, and climate.

Objective
Students will have a broad understanding of the hydrological, biogeochemical, and geomorphological functioning of mountain catchments. They will practice using data and models to frame and test hypotheses about connections between streams and landscapes.

Content
Streams are integrated monitors of the health and functioning of their surrounding landscapes. Streams integrate the fluxes of water, solutes, and sediment from their contributing catchment area; thus they reflect the spatially integrated hydrological, ecophysiological, biogeochemical, and geomorphological processes in the surrounding landscape. At a practical level, there is a significant public interest in managing forested upland landscapes to provide a reliable supply of high-quality surface water and to minimize the risk of catastrophic flooding and debris flows, but the scientific background for such management advice is still evolving.

Using a combination of lectures, field exercises, and data analysis, we explore the processes controlling the delivery of water, solutes, and sediment to streams, and how those processes are affected by changes in land cover, land use, and climate. We review the connections between process understanding and predictive modeling in these complex environmental systems. How well can we understand the processes controlling watershed-scale phenomena, and what uncertainties are unavoidable? What are the relative advantages of top-down versus bottom-up approaches? How much can "black box" analyses reveal about what is happening inside the black box? Conversely, can small-scale, micro-mechanistic approaches be successfully "scaled up" to predict whole-watershed behavior? Practical problems to be considered include the effects of land use, atmospheric deposition, and climate on streamflow, water quality, and sediment transport.

Lecture notes
Slides of lecture are available for download as PDF. Supplementary material will be provided during lecture.

Literature
Recommended and required reading will be specified at the first class session (with possible modifications as the semester proceeds).

101-0269-00L Numerical Modelling in Fluvial Hydraulics and River Engineering

Abstract
The basics of numerical modelling of fluvial hydraulics and river engineering problems are presented. The governing equations for flow and sediment transport in open channels and corresponding numerical solution strategies are introduced. The theoretical parts are discussed by examples.

Objective
Get to know possibilities and limitations of numerical modelling in fluvial hydraulics and river engineering.

Content
- Governing equations and modelling approaches
- Initial and boundary conditions
- Simulation process and grid generation
- Numerical methods: basics, accuracy and stability
- Examples of numerical schemes, 1D and 2D models

Lecture notes
Slides of lecture are available for download as PDF. Supplementary material will be provided during lecture.

Literature
Relevant books and citations will be mentioned.

Prerequisites / notice
Exercises are based on the simulation software BASEMENT (www.basement.ethz.ch), the open-source GIS Qgis (www.qgis.org) and code examples written in MATLAB. The applications comprise one- and two-dimensional approaches for the modelling of flow and sediment transport.


Master Thesis

Number

Title

Type

ECTS

Hours

Lecturers

118-0121-00L Master’s Thesis

Abstract
Students propose relevant research topics from their home countries, or from Latin American research projects, around which individual study programmes are devised, and on which they write their thesis. The Master thesis is supervised by scientific staff at ETH and collaborating institutions, and is based on the student's academic or professional experience.

Objective
The Master Thesis research takes place throughout the duration of the MAS Programme (12 months), complimented by Master level coursework and Seminars focusing on Water Resources and Sustainability. Students become familiar with new research techniques, and receive guidance from experts. The topic of the research should address a relevant water resources problem in the student's home country, and is aimed at enhancing collaboration between academics and professionals in Latin America and in Switzerland.

MAS in Sustainable Water Resources - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Compulsory</td>
<td>E-</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
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Data: 06.12.2018 13:04

Autumn Semester 2015

Page 887 of 1432
### Key for Hours

<table>
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<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
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</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
MAS in Urban Design

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>065-0070-00L</td>
<td>MAS Programme “Urban Transformation in Developing Territories”</td>
<td>E-</td>
<td>0 credits</td>
<td>16S</td>
<td>M. Angéli</td>
</tr>
</tbody>
</table>

After successful completion the students achieve 65 Creditpoints.

Abstract

The MAS programme is structured around an investigation of transforming urban conditions as they pertain to global phenomena, and the development of practical tools for operating within such domains.

Objective

The programme aims at developing a culture of urban research and design that will enable the participant to actively engage in envisioning future urban scenarios. Secondly, a strong emphasis is put on methodology, process design and communication in order to prepare for the interdisciplinary negotiating agenda of the urban designer as future member of professional design offices, academic research teams, public services or communication agencies.

Content

Each year, the MAS studio will focus on two specific topics of urban research and two existing sites on which to intervene in the form of two design research studios. The sites are preferably territories under development pressure with existing groups of urban actors to engage with.

MAS in Urban Design - Key for Type

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

Key for Hours

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

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive disciplines. It offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Discovering Management offers an integrated learning system, which combines in an innovative format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

By covering key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

The lectures for Discovering Management are designed to broaden the participant's understanding of the principles of entrepreneurial management, emphasizing the interdependence of various specialties in the development and management of a firm. For this reason, the lectures are structured on the basis of a coherent business model and will be presented by the respective area specialists at D-MTEC. The lectures broaden the view and the understanding of technology by interlinking it with society. Corporate sustainability, for example, introduces economic, ecological and social issues that are relevant to all engineering disciplines. Practical examples stimulate the students to assess these issues and be aware of their responsibilities as engineers. Technology and innovation management, to mention a second example, focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students' ability to see the business and social consequences of their 'technical' decisions.

Critical skills will be trained by the case study exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant's appreciation for the complex tasks companies deal with.

Discovering Management attempts to overcome the limitations of traditional teaching curricula of management in technical universities, which often merely focus on transferring specific skills to students, e.g. planning or forecasting. In response to the new challenges for entrepreneurial decision-making, students will be offered the opportunity to actively engage in an advanced business game simulation; a business game that establishes a link between business management theory and business management in practice. The simulation presents a realistic model of a company and provides participants with the opportunity to quickly gain the lasting effects of practical experience in a risk-free environment. All this provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyze the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

Complementary exercises for the module Discovering Management.

Prerequisite: Participation and successful completion of the module Discovering Management (351-0778-00L) is mandatory.

This course is offered complementary to the basis course 351-0778-00L, "Discovering Management". The course offers additional exercises and case studies.

The course offers additional exercises and case studies concerning:
Strategic Management; Technology and Innovation Management; Operations and Supply Chain Management; Finance and Accounting; Marketing and Sales.

Please refer to the course website for further information on the content, credit conditions and schedule of the module: www.dm.ethz.ch

Open- and User Innovation introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

Number | Title                                                                 | Type | ECTS | Hours | Lecturers                                                                 |
---      | ---                                                                 | ---   | ---   | ---   | ---                                                                        |
351-0555-00L | Open- and User Innovation | Z     | 3 credits | 2G   | S. Häfliger, S. Spaeth |
Abstract | The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. |
Objective | The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations. |

Discovering Management (Exercises) 351-0778-01

Abstract | Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC. |
Objective | Discovering Management offers an integrated learning system, which combines in an innovative format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation. |
Content | The lectures for Discovering Management are designed to broaden the participant's understanding of the principles of entrepreneurial management, emphasizing the interdependence of various specialties in the development and management of a firm. For this reason, the lectures are structured on the basis of a coherent business model and will be presented by the respective area specialists at D-MTEC. The lectures broaden the view and the understanding of technology by interlinking it with society. Corporate sustainability, for example, introduces economic, ecological and social issues that are relevant to all engineering disciplines. Practical examples stimulate the students to assess these issues and be aware of their responsibilities as engineers. Technology and innovation management, to mention a second example, focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students' ability to see the business and social consequences of their 'technical' decisions. Critical skills will be trained by the case study exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant's appreciation for the complex tasks companies deal with. Discovering Management attempts to overcome the limitations of traditional teaching curricula of management in technical universities, which often merely focus on transferring specific skills to students, e.g. planning or forecasting. In response to the new challenges for entrepreneurial decision-making, students will be offered the opportunity to actively engage in an advanced business game simulation; a business game that establishes a link between business management theory and business management in practice. The simulation presents a realistic model of a company and provides participants with the opportunity to quickly gain the lasting effects of practical experience in a risk-free environment. All this provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyze the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities. |

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.
Content

This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

Lecture notes

The slides of the lectures are made available and updated continuously through the SMI website.

Literature

Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

Reading assignments: please consult the SMI website:

<table>
<thead>
<tr>
<th>363-0511-00L</th>
<th>Managerial Economics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z 4 credits</td>
<td>S. Rausch, V. Hoffmann</td>
</tr>
</tbody>
</table>

Abstract

Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to optimization, the theory of consumer demand, the theory of the firm, industrial organization and decision making under uncertainty are studied using methods of numerical analysis, statistical estimation, game theory and constrained optimization.

Objective

The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic concepts for firm-level management decisions. The course covers a number of models and methods of analysis which are commonly employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization, applications of game theory to contract design and agency theory, and the theory of decision making under uncertainty focusing specifically on long-term investment decisions. The course will include three lectures by Professor Volker Hoffman focusing on related case-studies in management.

Literature

Mikroökonomie (Pearson Studium - Economic VWL) Gebundene Ausgabe, August 2013, Robert S. Pindyck, Dr. Daniel L. Rubinfeld.

Prerequisites / notice

The course acquaints students who have previous not studied economics to economic concepts and quantitative methods which can be used to solve management decision problems.

Management, Technology and Economics (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
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</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
</tbody>
</table>

| Z  | Courses outside the curriculum |
| Dr | Suitable for doctorate |
| E- | Recommended, not eligible for credits |

Key for Hours

| V  | lecture |
| G  | lecture with exercise |
| U  | exercise |
| S  | seminar |
| K  | colloquium |

| P  | practical/laboratory course |
| A  | independent project |
| D  | diploma thesis |
| R  | revision course / private study |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization. We develop a "systemic" view of organizations. We look at organizations as part of an industry context, which is affected by different elements like strategy, structure, culture, tasks, people and outputs. We consider how managerial decisions are made in any one of these domains affect decisions in each of the others.


Selected readings from the book and additional learning materials will be available on the course Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=1287

All the materials uploaded on Moodle must be considered as required readings.

We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and offer e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a group project, focusing on one of the four sustainability challenges of water, energy, mobility, and food.

Understand the limits and the potential of corporate sustainability for sustainable development

Develop critical thinking skills that are useful for corporate sustainability (argumentation, communication, evaluative judgment)

Be able to recognize and realize opportunities for corporate sustainability in a business environment

Overview of the grand sustainability challenges of Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for corporate strategy, marketing & leadership, technology & innovation, and financial markets.

Critical thinking skills for corporate sustainability

In-depth case study of concrete corporate sustainability challenge in the group project phase, such as: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze radical innovations for sustainability? How to invest money in a sustainable way?

Presentation slides will be distributed prior to lectures.

Presentation slides will be distributed during the lecture

Due to didactic reasons originating from the case based approach, the number of participants is limited to 80. Registration through myStudies (first come, first served). If you are unable to sign up through myStudies, please contact the course assistant.

This courses conveys concepts and methods in strategic management, with a focus on competitive strategy. Competitive strategy aims at improving and establishing position of firms within an industry.

The lecture "strategic management" is designed to teach relevant competences in strategic planning and -implementation, for both professional work-life and further scientific development. The course provides an overview of the basics of strategy and the most prevalent concepts and methods in strategic management. The course is given as a combination of lectures about concepts/methods, and case studies where the students asked to solve strategic issues of the case companies. In two sessions, the students will also be addressing real-time strategic issues of firms that are represented by executives.

Contents:
- Introduction to strategy
- Industry dynamics I: Industry analysis
- Industry dynamics II: Analysis of technology and innovation
- The resource-based theory of the firm
- The knowledge-based theory of the firm

Session #0: (September 29) Organizational Issues & How to Solve a Case
Session #1: (October 6) Introduction
Session #2: (October 13) Industry Dynamics I
Session #3: (October 27) Guest Lecture
Session #4: (November 3) Industry Dynamics II
Session #5: (November 10) Resource-Based Theory
Session #6: (November 24) Knowledge-based Theory
Session #7: (December 1) Guest Lecture

For participants of the MAS-MTEC program we offer a complementary course Practicing Strategy in which students will apply the concepts of Strategic Management to their real-life contexts and organizations. Please register simultaneously for both courses if you want to take part in this course.

For more information please see: http://www.smi.ethz.ch/education/practicing-strategy.html

Deutschsprachige Unterrichtspräferenzen und andere Informationen finden Sie auf der zugehörigen Seite des Bachelorstudiengangs Management und Wirtschaftswissenschaften auf unserer Webseite.

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

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

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

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

This book also serves as textbook for LOS II (spring term) as well as ERP and SCM software systems (autumn term). In addition powerpoint-handouts and documents for case studies.

For the lecture students will get access to one of the leading online teaching platforms (called edX) also offered by other top universities (incl. MIT, Harvard, Berkeley, etc.). Using the edX platform, will allow students to collaborate in online discussions, solve online exercises and present a short educational video as part of a group project.

Key Topics:
- Business model innovation; (digital) business model patterns; business value of IT; the concept of integration; transaction cost perspective; network economics perspective: essentials and impact of web 2.0; internet of things, mobile computing, market places, social analytics and big data; IT governance and portfolio management; entrepreneurship in the digital space, etc.

363-0445-00L Logistics, Operations and Supply Chain Management I W+ 3 credits 2G P. Schönseiber, E. Scherer Casanova

Abstract
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Objective
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Content
Strategic and tactical concepts in logistics, operations, and supply chain management: Conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the MRP II / ERP concept; business processes and methods; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.

Lecture notes

This book also serves as textbook for LOS II (spring term) as well as ERP and SCM software systems (autumn term). In addition powerpoint-handouts and documents for case studies.

Sales at 17.9.15, from 12:45, before and during brakes of the first lecture.

Prerequisites / notice
As for the lecture of the 3rd week (BEMAD, a much-liked Business Engineering and Management Ability Development game), this lecture (of Oct. 1) will follow a specific schedule in specific rooms. The schedule will be presented at Sept. 17 during the 1st lecture.

Due to the big number of students, about half of the students will play this game, instead of Oct. 1, at Friday afternoon, Oct. 2. Please be available. Thank you for your help in this matter.
This course provides an introduction to operations research methods in the fields of management science and economics. Requisite

The following topics are covered: Systems and models, linear models and the importance of linear programming, duality theory and

Prerequisites / notice

Students (at least in groups of two) must bring a laptop with MS Excel and the Excel Solver installed to class.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>3</td>
<td>F. Schweitzer, P. Mavrodiev</td>
</tr>
<tr>
<td>363-1004-00L</td>
<td>Operations Research</td>
<td>3</td>
<td>M. Laumanns</td>
</tr>
<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>3</td>
<td>M. Filippini</td>
</tr>
</tbody>
</table>

Content

Effective supply chains ought to be aligned with and support the achievement of the firms corporate, business and product strategies, taking into account future opportunities and risks. This course will familiarize students with modern supply chain management theory and practice to develop and manage supply chains. The topics covered range from fundamental logistics and supply chain concepts (e.g. push vs. pull, postponement) to the development of supply chain strategies, relationships and networks.

Course material will be available for download from the homepage of the Chair of Logistics Management:

http://www.scm.ethz.ch/teaching/courses.html

Literature

Login will be provided in the first lecture or can be obtained from the Teaching Assistant Dennis Schuler(dschuler@ethz.ch).

Prerequisites / notice

Any standard textbook in Operations Research is a useful complement to the course.

Lecture notes

W+ Lecture notes, exercises and reference material can be downloaded from Moodle.

Prerequisites / notice

Students (at least in groups of two) must bring a laptop with MS Excel and the Excel Solver installed to class.

Objective

A successful participant of the course is able to:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

Content

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

The course is structured along three main tasks:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

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

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

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

Lecture notes

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

Lecture notes

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

Prerequisites / notice

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

Lecture notes

Any standard textbook in Operations Research is a useful complement to the course.

Lecture notes

The following textbook is mandatory:


The following textbook is supplementary:


The following textbook is supplementary:


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

Prerequisites / notice

Students (at least in groups of two) must bring a laptop with MS Excel and the Excel Solver installed to class.

Objective

This course provides an introduction to operations research methods in the fields of management science and economics. Requisite

Mathematical concepts are introduced with a practical, problem-solving perspective.

Content

The following topics are covered: Systems and models, linear models and the importance of linear programming, duality theory and

Lecture notes

A printed script will be made available.

Prerequisites / notice

Undergraduate calculus, linear algebra, probability and statistics are a prerequisite.

Prerequisites / notice

Undergraduate calculus, linear algebra, probability and statistics are a prerequisite.

Objective

Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

Lecture notes

Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature
The book can also be used for the course ‘Principles of Macroeconomics’ (Sturm)

For students taking only the course ‘Principles of Microeconomics’ there is a shorter version of the same book:

Complementary:

Abstract
Resource and Environmental Economics

W+ 3 credits 2G  L. Bretschger, A. Braussmann

Economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of
effectiveness; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and
international aspects of resource and environmental economics.

Objective

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

Topics are:

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

Content

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

Lecture notes
Learning material and script can be found here:
https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature

363-0565-00L Principles of Macroeconomics

W+ 3 credits 2V  J.E. Sturm

Abstract
This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It
tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against
unemployment and inflation. What significance do international economic relations have for Switzerland?

Objective

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.

Content

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your
curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others
have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this
course will help you answer.
Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the
policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various
questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with
other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and
similar questions are always on the minds of policy makers.

Lecture notes
The course webpage (to be found at http://www.kof.ethz.ch/en/events/teaching/) contains announcements, course information and lecture
slides.

Literature
The set-up of the course will closely follow the book of

We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should
buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

363-0711-00L Accounting for Managers

W+ 3 credits 2V  J.P. Chardonnens
Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

Understand the different procedures involved in the accounting system
Record change in financial position
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation, acquisition, and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.

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

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

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

Bi-weekly out-of-class assignments and projects on covered subjects
Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time. Exemplary answers to the assignments will be posted online after the submission date for students to review. Some assignments will also be discussed in class.

Class participation: Class participation is encouraged and can greatly improve students' learning in this class. Class participation will not be graded; however, it will be considered favorably if a student is between grades. Note, however, that quality is more important than quantity. In this spirit, students are expected to attend class regularly and come to class prepared.

This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.

- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation

This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental design: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success is small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

Slides will be available on the TIMGROUP website.
Readings will be available on the TIMGROUP website.

No specific background in economics or management is required.

I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.
Objective

The course explains the key concepts and mechanisms of financial economics, their depth and then stresses how and why the theories and models fail and how this is impacting investment strategies and even a global view of citizenship, given the present developing crises in the US since 2007 and in Europe since 2010.

- Development of the concepts and tools to understand these risks and master them.
- Working knowledge of the main concepts and tools in finance (Portfolio theory, asset pricing, options, real options, bonds, interest rates, inflation, exchange rates)
- Strong emphasis on challenging assumptions and developing a systemic understanding of financial markets and their many dimensional risks

Content

1- The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.

2- Risks in financial markets
   - What is risk?
   - Measuring risks of financial assets
   - Introduction to three different concepts of probability
   - History of financial markets, diversification, market risks

3- Introduction to financial risks and its management.
   - Relationship between risk and return
   - Portfolio theory: the concept of diversification and optimal allocation
   - How to price assets: the Capital Asset Pricing Model
   - How to price assets: the Arbitrage Pricing Theory, the factor models and beyond

4- Financial markets: role and efficiency
   - What is an efficient market?
   - Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
   - Deviations from efficiency, puzzles and anomalies in the financial markets
   - Financial bubbles, crashes, systemic instabilities

5- An introduction to Options and derivatives
   - Calls, Puts and Shares and other derivatives
   - Financial alchemy with options (options are building blocks of any possible cash flow)
   - Determination of option value; concept of risk hedging

6- Valuation and using options
   - A first simple option valuation model
   - The Binomial method for valuing options
   - The Black-scholes model and formula
   - Practical examples and implementation
   - Realized prices deviate from these theories: volatility smile and real option trading
   - How to imperfectly hedge with real markets?

7- Real options
   - The value of follow-on investment opportunities
   - The timing option
   - The abandonment option
   - Flexible production
   - Conceptual aspects and extensions

8- Government bonds and their valuation
   - Relationship between bonds and interest rates
   - Real and nominal rates of interest
   - Term structure and Yields to maturity
   - Explaining the term structure
   - Different models of the term structure

9- Managing international risks
   - The foreign exchange market
   - Relations between exchanges rates and interest rates, inflation, and other economic variables
   - Hedging currency risks
   - Currency speculation
   - Exchange risk and international investment decisions

Lecture notes

Lecture slides will be available on the site of the lecture

Literature

Corporate finance
Brealey / Myers / Allen
Eight edition

+ additional paper reading provided during the lectures

Prerequisites / notice

none

Elecitves

Recommended Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Grote</td>
</tr>
</tbody>
</table>

Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.
Using uncertainty management by organizations and individuals as conceptual framework, risk management and risk implications of new technologies are treated. Three components of risk management (risk identification/evaluation, risk mitigation, risk communication) and underlying psychological and organizational processes are discussed, using company case studies to promote in-depth understanding.

**Objective**

- Understand basic components of risk management in organizations
- know and apply methods for risk identification/evaluation, risk mitigation, risk communication
- know psychological and organizational processes for managing uncertainty
- apply theoretical foundations to applied issues such as safety management, regulatory activities, and technology design and implementation in different domains (e.g. transport systems, IT, insurance)

**Content**

The syllabus includes the following topics:

- Elements of risk management
  - risk identification and evaluation
  - risk mitigation
  - risk communication
- Psychological and organizational concepts relevant in risk management
  - decision-making under uncertainty
  - risk perception
  - resilient organizational processes for managing uncertainty
- Case studies on different elements of risk management (e.g., rule making, training, managing project risks, automation)
- Group projects related to company case studies

**Prerequisites / notice**

The course is restricted to 40 participants who will work closely with the lecturers on case studies prepared by the lecturers on topics relevant in their own companies (Swiss Re, Skyguide, Swisscom).

### Course Topic and Learning Objectives:

**Course Code: 363-0311-00L**

**Psychological Aspects of Risk Management and Technology**

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>2V</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>363-0311-00L</td>
<td>Psychological Aspects of Risk Management and Technology</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>G. Grote, S. A. Maurer, J. Schmutz, R. Schneider, M. Zumbühl</td>
</tr>
</tbody>
</table>

**Abstract**

Using uncertainty management by organizations and individuals as conceptual framework, risk management and risk implications of new technologies are treated. Three components of risk management (risk identification/evaluation, risk mitigation, risk communication) and underlying psychological and organizational processes are discussed, using company case studies to promote in-depth understanding.

**Objective**

- understand basic components of risk management in organizations
- know and apply methods for risk identification/evaluation, risk mitigation, risk communication
- know psychological and organizational processes for managing uncertainty
- apply theoretical foundations to applied issues such as safety management, regulatory activities, and technology design and implementation in different domains (e.g. transport systems, IT, insurance)

**Content**

The syllabus includes the following topics:

- Elements of risk management
  - risk identification and evaluation
  - risk mitigation
  - risk communication
- Psychological and organizational concepts relevant in risk management
  - decision-making under uncertainty
  - risk perception
  - resilient organizational processes for managing uncertainty
- Case studies on different elements of risk management (e.g., rule making, training, managing project risks, automation)
- Group projects related to company case studies

**Prerequisites / notice**

The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students.

### Course Topic and Learning Objectives:

**Course Code: 363-0393-00L**

**Corporate Strategy**

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>2V</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>363-0393-00L</td>
<td>Corporate Strategy</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>S. Ben-Menahem</td>
</tr>
</tbody>
</table>

**Abstract**

This course focuses on the challenges in managing multi-business corporations, and covers topics related to the vertical and horizontal scope of business activities.

70% of the final grade consists of a final closed-book written exam and 30% of the final grade will consist of individual assignments and group debates.

**Objective**

Course Topic and Learning Objectives:

- Due to didactic considerations, the number of participants for this course is limited to 50.
- Please register through myStudies to enroll for the course.
- Slots are assigned on a first-come first-serve basis (in the order of the registration date on myStudies). We will confirm your registration by e-mail. If you have any inquiries about the course, please contact the course assistant.

Large- and medium-sized corporations play a central role in the economic activity of most developed and developing countries. Many of these organizations perform multiple business activities in multiple markets. In the face of increasing international competition, globalization, technological development, deregulation, and the emergence of new markets and industries, operating such a portfolio of business activities poses important managerial challenges forcing corporations to continuously re-consider their vertical and horizontal scope and boundaries.

The course Corporate Strategy draws from a wide range of theories and methods to develop an understanding of the conceptual frameworks, debates, and developments concerning decisions associated with the management of multi-business corporations. We will cover the key questions driving a firm's corporate strategy, including:

- In what markets to compete with which businesses?
- Which activities should be performed by the firm and which should be outsourced (i.e. "make" or "buy" decisions)?
- What are the most appropriate approaches to growth and divestiture?
- How do institutional forces impact corporate strategy?

Specifically, we will examine how organizations manage their portfolio of business activities and markets to achieve competitive advantage through vertical integration, cooperative strategies such as strategic alliances and joint ventures, corporate diversification, mergers and acquisitions, divestitures, and globalization/international strategies, and strategic renewal.

**Format:**

The course is a combination of lectures about concepts/methods, guest lectures, case studies/assignments, and group debates.

**Prerequisites / notice**

The course is a combination of lectures about concepts/methods, guest lectures, case studies/assignments, and group debates. Having participated in the course Strategic Management by Prof. Georg von Krogh/Dr. Zeynep Erden is an advantage but not a requirement.
The lecture treats the main challenges of business transformation and the alignment of corporate development and IT activities. It presents a holistic approach to business transformation projects by introducing an integrated model dealing with three main design areas “strategy”, “processes” and “information systems” and applying this model to various case studies.

**Objective**

The goal of the lecture is to understand the main challenges of corporate transformation and to demonstrate the application of a holistic project procedure model for corporate transformation projects with special emphasis on the alignment of business and IT.

The student should understand and be able to explain the main reasons for corporate transformation, the relevant management processes to manage corporate transformation, the interdependencies between strategy, processes and information systems, especially how this three levels interrelate, the critical success factors for the successful accomplishment of large scale corporate transformation projects, the main instruments of project, quality and change management and the different types of resulting IT projects.

**Content**

The globalization of the world leads to an increasingly faster pace in business transformation. Enterprises have to adapt faster and even faster to the environmental changes in a global economy to remain competitive and to make sure they stay in business. In today's information age this does not only mean to adapt business strategy and business processes but also to adapt information systems to the new circumstances. The fast adaptation trough large scale corporate transformation projects that change strategy, business processes and information systems is critical to ensure competitiveness for tomorrow. The introduction of new business processes and information systems typically takes years in very complex large scale projects. Many projects fail because of insufficient alignment between decision makers in business and IT. Unclear understanding of the overall project scope, undefined roles and responsibilities, unclear project processes, quality problems and resistance to change are some typical problems found in such projects. The lecture is subdivided into the following modules:

- Corporate development introduction and motivation,
- Parallelization of corporate development and complexity reduction,
- Planning process and project portfolio management in corporate development,
- Management of large scale projects integration of strategy, processes and information systems,
- Quality management in large scale projects,
- Project management in large scale projects,
- Change management within projects. The lecture is accompanied by four case studies that are used to exemplify the contents of the lecture by applying the concepts to real situations in corporate life.

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### 363-0427-00L Business-IT Alignment

*W* 3 credits  
L. Goutas

**Abstract**

Attending the lectures is imperative to complete the assignments.

**Objective**

What, how, and outcomes of Business-IT Alignment. This course will introduce tools for strategically aligning business and IT, managing the alignment process, and evaluating the alignment outcomes.

**Content**

Students will not only learn about the tools and frameworks to align business and IT, but also learn how to apply the tools / frameworks to real cases.

Lecture 1: IT potential and IT Strategy, business process change, IT portfolio and IT HR management (with case examples)

Lecture 2: Evaluating IT investment and alignment maturity assessment, Digital Strategy

Lecture 3: Case Presentations

Check the course website: [http://www.mis.ethz.ch/teaching/HS13/BsnsIT2013](http://www.mis.ethz.ch/teaching/HS13/BsnsIT2013)

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### 363-0562-01L Economics of Innovation and Growth

*W* 3 credits  
O. Tejada Pinyol

**Abstract**

Overview how the world has developed. Understanding the role of innovation for economic growth. Design of policies to foster innovation and growth.

**Objective**

The three goals of the lecture. First, understanding how the world has developed over the last centuries and the proximate and fundamental causes of economic growth. Second, understanding and application of the basic models of economic growth. Third, design of policies to foster innovation and growth to reduce the large wealth differences in the world.

**Content**

1. Introduction
2. Neoclassical Growth Theory
3. Innovations and Growth (New Growth Theory)
4. Growth Policy
5. Institutions and Growth

**Literature**

The transparencies used in the lectures will be distributed to the participants.

Core literature:


Additional literature:

Climate change is one of the most pressing issues that governments and the global community have to face. This course outlines the problem of climate change and discusses the economic solutions (both domestic and international) to this problem.

This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic solutions to combating climate change (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.

Economics of pollution, Optimal level of greenhouse gases, International Environmental Agreements, Tradable pollution permit markets, : Carbon Taxes, Technological innovation and R&D, The optimal approach to control Climate change, The future of Climate change policy

Required reading:
Peman et al. (2003), Natural Resource and Environmental Economics, Pearson Addison Wesley. Also, Journal articles will be cited

Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended

The idea of this course is to familiarize students with instrumental variables estimation of linear regression models and the estimation of models with limited dependent variables as well as of nonlinear regression models. While most of the material covered will pertain to cross-sectional data, we will also work on selected issues with panel data.

I will provide STATA programs and show the execution thereof. After having participated in this course, students will be able to carry out simple research projects and understand the basics of intermediate econometrics. In particular, they will be able to write simple programs in STATA and to qualify their own and others’ regression output relating to problems covered.


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The block-seminar combines lectures introducing negotiation, negotiation engineering and specific aspects of successful negotiation with understanding how taxes influence decisions of multinational firms.

3 credits

Students obtain a concentrated insight into key aspects of the field of negotiations, negotiation engineering and specific aspects of successful negotiation. Multiple opportunities to apply that knowledge in different negotiation situations allow for an in-depth learning experience.

1 credit

Distinguished guest speakers will be invited.
With the aim of preparing the students to take on managerial responsibility, this 2x5 days-seminar teaches basic and practical management skills. A practical learning approach is ensured by conveying management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).

### Additional Electives Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0345-01L</td>
<td>Lecture Cycle Purchasing</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>S. Wagner, R. Boutellier</td>
</tr>
<tr>
<td>Objective</td>
<td>Ziel der Veranstaltung ist es einen Einblick in die praktischen Herausforderungen von Einkaufs- und Beschaffungsmagazijnern zu erlangen, den Einkauf als wichtige Unternehmensfunktion kennen-zulernen und seine Bedeutung für den Unternehmenserfolg zu erkennen.</td>
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</table>


<table>
<thead>
<tr>
<th>Number</th>
<th>Logistics, Operations, and Supply Chain Management (I, Additional Cases)</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0445-02L</td>
<td>Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.</td>
<td>W</td>
<td>1 credit</td>
<td>2A</td>
<td>P. Schönleben</td>
</tr>
<tr>
<td>Abstract</td>
<td>With the aim of preparing the students to take on managerial responsibility, this 2x5 days-seminar teaches basic and practical management skills.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Objective</td>
<td>To convey management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).</td>
<td></td>
<td></td>
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</tbody>
</table>
| Content      | 1 Fundamentals of Communication Psychology  
2 Communication in Business-Life  
3 Fundamentals of Leadership  
4 Self-Management and Life Balance  
5 Leadership Tools  
6 Problem Solving and Decision Making Techniques  
7 Performance Coaching  
8 Conflict Management  
9 Personality  
10 Summary-Day, Domino-Examination |
| Lecture notes | Will be provided as electronic version at www.entrepreneurship.ethz.ch at least one week before the seminar starts |
| Prerequisites / notice | Special permission from lecturers required  
10 days in two weeks, 09:00-17:00 |

The number of participants is limited. Please send an email to bms@ethz.ch by 03.08.15 for your registration.

**Week I: 17.08.15 to 21.08.15**
**Week II: 07.09.15 to 11.09.15**

<table>
<thead>
<tr>
<th>Number</th>
<th>Technology Entrepreneurship</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0790-00L</td>
<td>Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>U. Claesson, P. Baschera, F. Hacklin</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.</td>
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<tr>
<td>Content</td>
<td>See course website</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Lecture slides and case material</td>
<td></td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Alliance Advantage - Exploring the Value Creation</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>363-0861-00L</td>
<td>Potential of Collaboration</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>C. G. C. Marxt</td>
</tr>
<tr>
<td>Abstract</td>
<td>The development of new business models coping with the constantly augmenting complexity of technologies and systems as well as the ever increasing global competition force organizations to focus on close collaboration with key partners. These alliances are key value creation opportunities and constitute the core part of this lecture.</td>
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</tbody>
</table>
Objective
Learning outcomes professional competence
- The students learn and understand the management basics of inter-firm cooperation and organizational networks (business models, incl. risk, communication, etc.)
- Realize the value creation potentials of alliances (added value)
- Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
- Apply tools hands on in real companies (in coll. with companies)

Learning outcomes methodological competence
- Writing academic papers
- Developing structured documentation of interviews
- Transferring theory directly into application
- Contributing to the learning journey

Learning outcomes social competence
- Work together with industrial partners
- Improving communication skills as basics for collaboration
- Developing and applying teamwork skills
- Coping with conflicts resolution in teams

Content
The constantly augmenting complexity of technologies and systems, the increased pressure caused by competition, the need for shortening time-to-market and the thereby implied growing risks force organizations to increasingly focus on core competencies. Collaboration with external partners is a key value creation opportunity for successful ventures. This type of cooperation also has implications on daily management activities. This lecture will provide a better understanding of special requirements needed for management of cooperation issues.

Content:
- Introduction to theory and management of inter-firm collaboration and networks.
- Description of the formation, management and evolution of collaborations and networks.
- Collaborations in marketing, development, manufacturing (e.g. NUMMI).
- Special forms of collaborations: mergers & acquisition (e.g. pre- and post-merger activities, joint venture, strategic alliances (e.g. Doz & Hamel, networks, virtual communities)

Learning journey:
In an introductory lecture we will give an overview of the theoretical framework and explain the concept of the lecture (Sept. 18, 2014). In weeks 2-5 you will work on the first assignment on six different aspects of the underlying framework: strategy and activities, structure and process, culture and people orientation, interaction and roles, risk and trust, knowledge and learning. This first assignment will give you the basics to participate in the second part (Oct.30-31, 2014) of this seminar. There you will present the results of the first assignment and get additional theoretical input to perform the 2nd assignment. The second assignment will be to analyze real alliance projects in the partner companies. The final lesson will be used as a best practice exchange together with our industrial partners (Dec.18, 2014).

Lecture notes
- Lecture script
- Current course material
- Harvard Case Studies
- Reader with current publications

Literature
A list with recommended publications will be distributed in the lecture.

Additional Books:
- HBR Collaborating Effectively ISBN 978-1-4221-6264 4
- HBR on Mergers and Acquisitions: ISBN 1-57851-555-6

Prerequisites / notice
The number of students participating in the lecture is limited to 30.

363-0884-00L Industrial Engineering and Management Methodology for Theses in Companies W 1 credit 1G R. M. Alard

Abstract
This course is a preparation course for theses in industry: Criteria of scientific work, writing the final report, using research resources at ETH. Using case studies, content of other lectures is discussed with regard to the special challenges during theses: Systems Engineering, Social science methods for empirical data collection and analysis, project management, presentation techniques.

Objective
The objective of this course is to provide students with a practical toolset of techniques, procedures and hints for a successful scientific thesis (Bachelor/Master/MAS Thesis) in industry. The course is held by assistants of professorships at D-MTEC.

Content
Methodology: Systems Engineering, problem solving process, situation analysis, SWOT, objectives, solution finding, evaluation.

Social science methods for empirical data collection and analysis: how to develop a good research question: methodological awareness and practical considerations, criteria in social research: reliability and validity.

Research Designs and Strategies: qualitative and quantitative research.

Methods for data collection and analysis: observation, interview, questionnaire, document and literature analysis, and combinations.

Project Management: tasks plan, milestones, roles, communication
Scientific work: research, resources, citation, argumentation
Presentation: techniques, procedure, handouts, significance
Final report: organization, layout, figures, formal requirement, appendix

Lecture notes
http://www.timgroup.ethz.ch/education/Courses_at_TIMGROUP

Handouts of the presentations / course materials have to be downloaded and printed out before the course (see link above).
Further reading:


The course is intended for students who want to carry out a thesis in industry, in general these are:

1. MSc-students MTEC or MAVT with master thesis (MA) during the next term and supervised by MTEC, (corresponds to 3rd or 4th semester Master) and
2. BSc-students MAVT with bachelor thesis (BA) in industry and supervised by MTEC, as well as with full MTEC focus (corresponds to 5th or 6th semester Bachelor) or
3. MAS MTEC students in 3rd semester for MA during the next term.

Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering. 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.

Other students on request (limited places).

Important: the chair coaching your BA/MA defines whether the course is mandatory. Please contact your chair!

Electronic enrollment until 08.09.2015 required. Without electronic enrollment participation in the course can't be confirmed. The course is held "en bloc" at the beginning of the semester.

Date: Friday 11.09.2015 (13:15-17:00), location: HG E33.1 (ETH main building) and Saturday, 12.09.2015 (09:15-17:00), location: HG E33.1 (ETH main building). Participation at both days required (Friday afternoon and Saturday whole day).

The course is held in English; handouts are available in English.

Besonderes (deutsche Version):

Der Kurs richtet sich an Studierende, welche an einer Professur des D-MTEC eine Arbeit in der Wirtschaft schreiben werden. Im Allgemeinen sind dies:

1. MSc-Studierende MTEC oder MAVT mit Masterarbeit (MA) im kommenden Semester, die vom MTEC betreut wird, (entspricht 3. oder 4. Semester Master) sowie
2. BSc-Studierende MAVT mit Bachelorarbeit (BA) in der Wirtschaft, die vom MTEC betreut wird, sowie mit vollem MTEC Fokus (entspricht 5. oder 6. Semester Bachelor) oder


Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).

Wichtig: die Professur, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!

Elektronische Einschreibung bis zum 08.09.2015 notwendig. Ohne elektronische Einschreibung kann Ihre Teilnahme am Kurs nicht bestätigt werden.

Der Kurs wird als Blockkurs zu Beginn des Semesters gehalten.

Termin: Freitag, den 11.09.2015 (13:15-17:00) im HG E33.1 und Samstag, 12.09.2015 (09:15- ca. 17:00) im HG E33.1 (ETH Hauptgebäude). Anwesenheitspflicht an beiden Tagen (Freitagnachmittag und Samstag ganztags).

Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.

363-0881-00L Semester Project Small W 3 credits 6A Professors

Abstract

The semester project (90 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Objective

The semester project (90 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

363-0883-00L Semester Project Large W 6 credits 13A Professors

Abstract

The semester project (180 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Objective

The semester project (180 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

363-1021-00L Monetary Policy W 3 credits 2V J.E. Sturm, D. Kaufmann

Abstract

The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current real world issues.
This lecture will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.


Basic knowledge in international economics and a good background in macroeconomics. The course website can be found at: http://www.kof.ethz.ch/en/events/teaching/

Economics of Regulation

363-1024-00L

Abstract

This course introduces the economic theories and practices of governmental market regulation. We review related theories in microeconomics and apply them to various industries such as energy, telecoms and finance. We discuss different types of market failure in these markets, the ideal interventions, the real life practices and their evolutions. And we also learn about how to evaluate the policies.

Objective

- To deliver the understanding about why and when regulations are needed; to make students familiar with common regulatory policies; and to let students know about some very famous cases;

- To make a systematic review of the microeconomic theories that are related to regulation, specifically including game theory, industrial organization, environmental economics, and contract theory. Furthermore, by applying these theories to the regulatory problems, we want to show how one can use microeconomic theories to explain and solve real-life issues.

- By the end of the course, students are expected to have enhanced their understandings of the related microeconomic theories, and have strengthened the abilities to explain, to analyze, and to solve regulatory problems.

Content

Topics include:
- Introduction (market efficiency and failure);
- Classical regulatory tools (Price regulations and more);
- Monopoly power and dominance;
- Regulating the utilities (Electricity and energy, Telecommunications, Environmental regulation, Financial regulation);
- Cost-benefit analysis;
- The asymmetric information problem in regulation.

Literature

Lodge, M., M. Cave and R. Baldwin (eds.), The Oxford Handbook of Regulation, Oxford University Press, 2010. (accessible online via the school network)


Prerequisites / notice

Students are expected to have taken at least one basic microeconomics course. Knowledge about game theory, industrial organization and public economics will be useful. Knowledge about contract theory is a plus.
Objective

We will discuss and develop answers to the following questions:

- What do I want to achieve in my life?
- Why is it so important to define goals?
- What decision criteria can I use as a guide?
- How do potential career paths look like? What are the possibilities?
- How does the life cycle of a career look like? What are the alternatives?
- How do I increase my chances of success/reaching my goals?
- What kind of advice can experienced captains of industry give?
- Why is a periodic check of my goals and my progress necessary?

Content

INTRODUCTION (7.10.2015)
Awareness building / Overview on the career life cycle / Examples from praxis / Exchange of experiences / Approach for goalsetting / Introduction to the success secrets of a career

ORIENTATION AND GOAL SETTING (14.10.2015)
Class discussion of the success secrets of a career / Orientation on career options / Discussion of possible decision criteria / Initial formulation of concrete goals

External guest speaker: Inspiring Start-up Entrepreneur

CAREER DEVELOPMENT PLANS (21.10.2015)
Exchange w/representatives of industries / Personal Values & Norms vs Corporate Identity / Work-Life Balance Gender / Diversity / Summary of discussions / Best practice / Modification/Sharpening of goals

External guest speaker: Dr. Alexandre Grêt, CEO, HaslerRail AG

DETAILING OF INDIVIDUAL CAREER PLANS (28.10.2015)
Development of detailed individual career plans / Next steps / action plan / Tips & Tricks for careers in organizations and entrepreneurship

External guest speaker: Dr. Alexandre Grêt, CEO, HaslerRail AG

REVIEW & APPLICATION COUNSELING (04.11.2015)
Review/check of goals and career plans / Motivation letter / CV / Preparation for interviews

INTERVIEW TRAINING (11.11.2015)
External guest speaker: Thomas Vellacott, CEO, WWF Switzerland

Abstract

The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport policy (e.g. road pricing, public transport tariffs, investment in infrastructure etc.). The second part of the course will consider some case studies where we will apply the tools acquired in the first part to actual policy issues.

Prerequisites / notice

Motivation. Strategic long-term view.

Economics of Urban Transportation

Course slides will be made available to students prior to each class.

Literature

Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).
Part 6: Topics to be covered on research papers/case studies.
Abstract
The course focuses on the establishment of sustainability in firms' supply chains (that is, in their internal operations, in their logistics processes, and in their upstream supply chains). We will consider how supply chains can become more sustainable, as well as the extent to which firms are interested in such a development.

Objective
This course aims to equip students with an in-depth knowledge of the sustainability-related challenges and problems within supply chain management, and suggests some tools for managing these challenges. Equally importantly, the course seeks to capacitate students for understanding and analyzing the tradeoffs and conflicts of target within sustainable supply chain management.

The content of the course is closely linked to the latest research in the field, meaning that the absence of simple solutions will be the rule, rather than the exception. Moreover, the course will be highly interactive, and there will be intensive coursework during the course.

Content
The preliminary course outline is as follows:

Module 1: Motivation for SusSCM
- Sustainable development, sustainability, and corporate social responsibility
- Importance of SusSCM
- Motivation for firms to engage in SusSCM
- Specificity of SusSCM

Module 2: Supply chain sustainability topics and issues in an overview
- Types of issues
- Juxtaposing the three dimensions of the triple-bottom line
- Issue reporting
- Dilemmas for firms

Module 3: Sustainable operations management
- Lean and green
- CO2 avoidance
- Recycling
- Closed-loop SCM

Module 4: Sustainable logistics
- Forward vs. reverse logistics
- Sustainable transportation
- Sustainable warehousing
- Sustainable packaging
- Design of sustainable logistics networks

Module 5: Sustainable purchasing and supply management
- Management of the entire supply base in global sourcing contexts
- Sustainable supplier management processes
- Information processing prerequisites to sustainable supplier management processes
- Sustainability-oriented supply chain risk management

Module 6: Emerging topics in sustainable supply chain management

Wrap-up

Lecture notes
The course material will be available for download from the homepage of the Chair of Logistics Management:
http://www.scm.ethz.ch/teaching/Courses. The login will be announced in the first lecture. In addition, we will employ scientific publications and case studies as readings which are provided throughout the course. Supplementary textbooks are listed below in the literature section.

Literature
Supplementary textbooks:

Prerequisites / notice
There are no formal prerequisites. However, to profit most from the course, it would be desirable if students attended the MTEC courses on Strategic Supply Chain Management (MTEC MSc course no. 363-0453-00L), on Purchasing and Supply Management (MTEC MSc course no. 363-0452-00L) and on Corporate Sustainability (MTEC MSc course no. 363-0387-00L) beforehand. Moreover, the course builds on and details lectures on Sustainable Supply Chain Management within the course LOS II: Manufacturing Strategies - From Supply Chain Design to Factory Planning II (MTEC MSc course no. 363-0448-00L).

851-0735-09L Workshop & Lecture Series on the Law & Economics of Innovation

Abstract
This series is a joint project by ETH Zurich and the University of Zurich. It provides an overview of interdisciplinary research on intellectual property, innovation, antitrust and technology policy. Scholars from law, economics, management and related fields give a lecture and/or present their current research. All speakers are internationally well-known experts from Europe, the U.S. and beyond.

Objective
After the workshop and lecture series, participants should be acquainted with interdisciplinary approaches towards intellectual property, innovation, antitrust and technology policy research. They should also have an overview of current topics of international research in these areas.

Content
The workshop and lecture series will present a mix of speakers who represent the wide range of current social science research methods applied to intellectual property, innovation, antitrust policy and technology policy issues. In particular, theoretical models, empirical and experimental research as well as legal research methods will be represented.

Lecture notes
Papers discussed in the workshop and lecture series are posted in advance on the course web page.
entrepreneurial leadership n
limited number of participants.
students apply with motivation letter, CV and a transcript of records no later than 25.8.2015. earlier applications welcome. send application to andreakurath@ethz.ch. once your application is confirmed, a registration in myStudies is possible.

abstract
this seminar provides the most ambitious and best performing master students at MTEC with the challenging opportunity of a real case on strategy, innovation and leadership in close collaboration with the top management of an outstanding company - in 2015: PwC Switzerland.

objective
in your team, you will work on a specific assignment that flows from the current strategic agenda of the board. while gaining substantial insights into the structure, dynamics and challenges of the advisory and assurance industry, you immerse into the business model and strategic landscape of the corporate partner. you visit their headquarter, conduct interviews with members of the management team, experienced consultants as well as internal and external experts before you discuss your ideas with top executives. to secure impact, it is key that you formulate your recommendations from a deep understanding of the authentic leadership culture of the corporate partner.

content
in this endeavor you are coached and supported by: - Guido Große, Chair of Work and Organizational Psychology - Stefano Brusoni, Chair of Technology and Innovation Management - Claude Siegenthaler, HSE University / The St. Gallen MBA - Georg von Krogh, Chair of Strategic Management and Innovation - Plus Baschiera, Chair of Entrepreneurship

prerequisites / notice
please apply for this course via the official website (www.mtec.ethz.ch) and send your application form together with a CV and transcript of records to andreakurath@ethz.ch.
apply no later than August 25, yet early registrations are welcomed. the number of participants is limited to 18.

ECTS: 4
participants receive a certificate.

363-1051-00L
Cases in Technology Marketing
number of participants limited to 20.
students have to apply for this course by sending a CV and an one-page motivation letter until 14.09.2015 to mgrohmann@ethz.ch. additionally please enroll via myStudies. places will be assigned on the basis of your motivation letter.

abstract
the core of this module is to introduce students to some key concepts in technology marketing and to familiarize them subsequently with the challenges that (marketing) managers face in technology intensive markets by using real life cases. students will have to "solve" current and past managerial problems and will be enabled to compare their solutions with what has actually been done.

objective
this module should enable students to deal with the uncertainty related to challenges in technology marketing by introducing them to some key concepts and letting them apply those concepts to real life cases. The competences acquired in this module are meant to go beyond the mere understanding of the study material by improving students' analytical skills and capacity for team work. Furthermore, students will be exposed to decision-making styles and procedures in companies.

prerequisites / notice
students have to apply for this course by sending a CV and a one-page motivation letter until 14.09.2015 to mgrohmann@ethz.ch.

363-1055-00L
Marketing Practice
please send your application documents (Cover Letter, CV, Transcript of Records, Reports) by 15.10.2015 to: mgrohmann@ethz.ch. once your application has been confirmed, a registration in myStudies is possible.

abstract
the course enables students to apply their knowledge from marketing and other disciplines to real life cases under the supervision of internationally operating partner companies.

objective
first, students have to assess and analyse real life problems in order to generate creative solutions.
secondly, students have to demonstrate that they are both - able to apply their knowledge from marketing theory to practice, as well as to communicate their ideas to other students and leading marketing executives.

content
the circle of excellence is a one-year talent program for outstanding students together with the universities of Münster, Cologne and Berlin. it aims at preparing the participants for interesting management tasks within various workshops in collaboration with our internationally operating partner companies, e.g. PanGas, L’Oréal, Henkel, McKinsey, EDEKA,...

prerequisites / notice
your profile:
- strong interest in marketing topics
- very good academic performance
- interesting and convincing personality

students have to organize the remaining phase of their studies in a way that they are able to participate in the workshops.
Due to didactic reasons, the number of participants is limited to 30.

All interested students are invited to apply for this course by sending a one-page motivation letter until 07.09.2015 to Florian Rittiner (frittiner@ethz.ch).

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

### Abstract
The purpose of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in multidisciplinary teams to solve a set of design challenges that are organized as a one-week, a three-week, and a six-week project. The final project will be in collaboration with an external project partner.

### Objective
During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

### Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

### Literature
The simulation project is intended for Master's or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Geneva Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations), of keeper of the minutes or of observers and analysts. Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the "Capitals" to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

Dates/Time/Location (GE = University of Geneva)

- 22 Sept. | ETH HG D 22 | 10:15-12:00 | Introduction
- 29 Sept. | GE Uni Mail Salle 1170 | 10:15-12:00 | Introduction to Negotiation Techniques (Dr. Vitalijs Butenko and Dr. Sibylle Zürcher, ETH)
- 6 Oct. | ETH HG D 16.2 | 10:15-12:00 | Distribution of the roles, composition of the negotiation tables, preparation of mandates for the HA (humanitarian approach)
- 13 Oct. | ETH HG D 22 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)
- 20 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | No session; Students deepen and summarize their mandates on one page (A4)
- 27 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates I (FMCT)
- 10 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates II (HA)
- 17 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Preparation Meeting
- 26 & 27 Nov. | GE Salles 407 et 408 | 10:00-18:00 | Simulation at Uni Dufour
- 1 Dec. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the results

Note:
The participation in the simulation on 26. and 27. November in Geneva is necessary.
The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation in Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(Technical note for registration: At this stage all registered students are on the waiting list)

► Supplementary Courses
The students have to deepen their knowledge in the area(s) of engineering/natural sciences in consultation with the responsible professor (tutor). Core courses and electives of D-MTEC can not be used as supplementary courses.

Course Catalogue of ETH Zurich

► Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>363-0879-00L</td>
<td>Practical Training</td>
<td>O</td>
<td>6 credits</td>
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<tr>
<td>363-0600-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>57D</td>
<td>Professors</td>
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</tbody>
</table>

Abstract

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

Objective

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

<table>
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<tr>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>363-1063-00L</td>
<td>Academic Writing Course</td>
<td>O</td>
<td>0 credits</td>
<td>1G</td>
<td>S. Milligan, L. Briegel-Jones</td>
</tr>
</tbody>
</table>

Abstract

This course for MTEC master's students will focus on developing and refining students' English writing skills and their understanding of the requirements and conventions of academic writing.
Objective

The aim of this course is to improve the academic writing skills needed to complete an MSc thesis successfully. The course provides theoretical input, practical writing exercises, and detailed individual feedback organised into one group lecture and four workshops in smaller tutorial groups.

Initially, the lecture provides an overview of the range of demands on academic essay and MSc thesis writers and outlines the academic expectations that students must meet. Our goal is to provide a basis for informed decisions when selecting a thesis topic and supervisor. Guidance is then provided in the workshops on planning the writing process effectively, and individual feedback is provided to enhance writing ability.

The course develops a range of practical and transferrable writing skills. Students can use these skills to improve the overall quality of their MSc theses and to produce their thesis more rapidly and efficiently. The writing skills developed here can be used beyond the MSc, whether students go on to complete a PhD or to produce reports and other documents in industry.

Content

Group lecture:
an introduction to writing an MSc thesis in D-MTEC
selecting topic and supervisor
academic expectations
avoiding plagiarism

Workshop 1:
the writing process
reading, note taking and planning
overview of the thesis structure
building academic vocabulary

Workshop 2:
writing methods sections
embedding figures and tables
structuring sentences and paragraphs
noun phrases and articles

Workshop 3:
introductions; results and discussion sections
analysis v description
writing critically
relative clauses

Workshop 4:
abstracts and conclusions
editing your own text
punctuation, spelling, and grammar

Lecture notes

Notes will be available after registration.

Management, Technology and Economics Master - Key for Type

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

Key for Hours

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>V</th>
<th>G</th>
<th>U</th>
<th>S</th>
<th>K</th>
<th>P</th>
<th>A</th>
<th>D</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>lecture</td>
<td>lecture with exercise</td>
<td>exercise</td>
<td>seminar</td>
<td>colloquium</td>
<td>practical/laboratory course</td>
<td>independent project</td>
<td>diploma thesis</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Mechanical Engineering Bachelor

1. Semester

First Year Examinations: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0261-00L</td>
<td>Analysis II</td>
<td>O</td>
<td>8 credits</td>
<td>5V+3U</td>
<td>U. Lang</td>
</tr>
<tr>
<td>Abstract</td>
<td>Differential and integral calculus for functions of one and several variables; vector analysis; ordinary differential equations of first and of higher order, systems of ordinary differential equations; power series. The mathematical methods are applied in a large number of examples from mechanics, physics and other areas which are basic to engineering.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Introduction to the mathematical foundations of engineering sciences, as far as concerning differential and integral calculus.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>U. Stammbach: Analysis I/II</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Die Übungsaufgaben (inkl. Multiple Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung. Es wird erwartet, dass Sie mindestens 75% der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.</td>
<td></td>
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</tr>
</tbody>
</table>

| 401-0171-00L | Linear Algebra I                              | O    | 3 credits | 2V+1U | N. Hungerbühler |
| Abstract | Linear algebra is an indispensable tool of engineering mathematics. The course offers an introduction into the theory with many applications. The new notions are practised in the accompanying exercise classes. The course will be continued as Linear algebra II. |
| Objective | Upon completion of this course, students will be able to recognize linear structures, and to solve corresponding problems in theory and in practice. |
| Content | Systems of linear equations, Gaussian elimination, solution space, matrices, LR decomposition, determinants, structure of linear spaces, normed vector spaces, inner products, method of least squares, QR decomposition, introduction to MATLAB, applications |
| Literature | * K. Meyberg / P. Vachenauer, Höhere Mathematik 1, Springer 2003 |
| Prerequisites / notice | Die Übungsaufgaben (inkl. Multiple Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung. Es wird erwartet, dass Sie mindestens 75% der wöchentlichen Serien bearbeiten und zur Korrektur einreichen. |

| 151-0501-00L | Kinematics and Statics                        | O    | 5 credits | 3V+2U | E. Mazza         |
| Objective | The understanding of the fundamentals of statics for engineers and their application in simple settings. |
| Content | Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction |
| Lecture notes | Übungsbänder |
| Literature | Sayir, M.B., Dual J., Kaufmann S., Ingenieurmecahnik 1: Grundlagen und Statik, Teubner |
| Prerequisites / notice | Active participation in the exercises is part of this course. It is expected, that students submit 3/4 of all exercises for control. |

| 151-0711-00L | Engineering Materials and Production I        | O    | 4 credits | 4G    | K. Wegener       |
| Abstract | The lecture covers the structure and the properties of metallic materials, in the focus are the branches: microscopic structure; thermally activated processes; solidification, elastic, plastic deformation, creep. Generally the lecture also refers to manufacturing, to the processing, and application of the concerning materials. |
| Objective | Understanding the basics of metallic materials for engineers who are confronted with material decisions in design and production. |
| Content | The lecture covers the structure and the properties of metallic materials, in the focus are the branches: microscopic structure as ideal and real structure, alloying, thermally activated processes e.g. diffusion, recovery, recrystallisation, solidification, elastic and plastic deformation and creep. Generally the lecture also refers to manufacturing, to the processing, and application of the concerning materials. |
| Lecture notes | yes |

| 151-0301-00L | Machine Elements                             | O    | 2 credits | 2V    | M. Meboldt, Q. Lohmeyer |
| Abstract | Introduction to machine elements and mechanical systems as basics of product development. Case studies of their application in products and systems, |
| Objective | The students get an overview of the main mechanical components (machine elements) which are used in mechanical engineering. Selected examples will demonstrate how these can be assembled into functional parts and complete systems such as machinery, tools or actuators. At the same time, also the problem of production (production-oriented design) is discussed. In concurrent lectures / exercises "technical drawing and CAD" the design implementation will be practiced. |
Content
- Innovation Process: A Quick Overview
- Stages of the planning and design process
- Requirements for a design and technical implementation
- Choice of materials - Basic principles of a material-specific design
- Manufacturing process - fundamentals of a production-oriented design
- Connections, fuses, seals
- Machine-standard elements
- Storage & guides
- Transmission and its components
- Drives

The idea of machine elements is complemented by case studies and illustrated.

Lecture notes
The lecture slides will be published beforehand on the website of the pd|z.

Prerequisites / notice
For Bachelor studies in Mechanical and Process Engineering, the lecture "Maschinenelemente" (HS) is examined together with "Innovationsprozess" (FS) in the exam "Basisprüfung Maschinenelemente und Innovationsprozess".

529-0010-00L Chemistry O 3 credits 2V+1U A. de Mello, K. Elvira

Abstract
This is a general chemistry course aimed at first year undergraduate students in the Department of Mechanical and Process Engineering (D-MAVT).

Objective
The aims of the course are as follows:
1) To provide a thorough understanding of the basic principles of chemistry and its application.
2) To develop an understanding of the atomic and molecular nature of matter and of the chemical reactions that describe their transformations.
3) To emphasize areas considered most relevant in an engineering context.

Content
Electronic structure of atoms, chemical bonding, molecular shape and bonding theory, gases, thermodynamics, chemical thermodynamics, chemical kinetics, equilibria, solutions and intermolecular forces, redox and electrochemistry.

Literature
The course is based on "Chemistry the Central Science" by Brown, LeMay, Bursten, Murphy and Woodward. Pearson, 12th Edition (international edition).

Additional First Year Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0321-00L</td>
<td>Technical Drawing and CAD</td>
<td>O</td>
<td>4 credits</td>
<td>4G</td>
<td>K. Shea</td>
</tr>
</tbody>
</table>

Abstract

Objective
The lecture and exercises teach the fundamentals of technical drawing and CAD. After taking the course students will be able to create accurate technical drawings of parts and assemblies as well as read them. Students will also be able to create models of parts and assemblies in a 3D, feature-based CAD system. They will understand the links with simulation, product data management (PDM) and additive manufacturing.

Content
Introduction to Engineering Design
Sketching in Engineering Design

Technical Drawing:
- projections and views
- cuts
- notations
- primitives
- ISO norm elements
- dimensioning
- tolerances
- assemblies
- documentation

CAD:
- CAD basics
- CAD modeling methods
- sketch modeling
- modeling operations
- feature-based modeling
- assemblies
- creating 2D drawings from 3D parts
- links to simulation, e.g. kinematics
- links to model variants and Product Data Management (PDM)
- links to additive manufacturing (3D printing)

Lecture notes
Lecture slides and exercise handouts are available on the course Moodle website: https://moodle-app2.let.ethz.ch/course/index.php?categoryid=56

Literature
In addition to the lecture material the following books are recommended (only in German):

TZ
Technisches Zeichnen: selbstständig lernen und effektiv üben
Susanna Labisch and Christian Weber
2008 Vieweg
eBook (accessible from the ETH domain): http://link.springer.com/book/10.1007/978-3-8348-9451-9/page/1

VSM Normen-Auszugs 2010
(kann in den Übungen bestellt und gekauft werden)

CAD
Marcel Schmid
CAD mit NX: NX 8
J.Schlembach Fachverlag
ISBN: 978-3-935340-72-4
Prerequisites / notice

This course is given as a lecture (1h/week) and an exercise (3h/week). Students are split into working groups for the exercises with a maximum of 20 students per group.

Semester Fee

A fee is charged for printed copies of the course handouts.

First Year Optional Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0501-02L</td>
<td>Kinematics and Statics (Colloquium)</td>
<td>Z</td>
<td>0</td>
<td>1K</td>
<td>E. Mazza</td>
</tr>
</tbody>
</table>

Abstract
Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power
Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction

Objective
The understanding of the fundamentals of Statics for engineers and their application in simple settings.

Content
Statics: equivalence and reduction of groups of forces; rest and equilibrium; basic theorem of statics; kinematic and static boundary conditions, applications to supports and clamps of rods and beams; procedures for determination of forces at supports and clamps; parallel forces and centre of gravity; statics of systems, solution using basic theorem and using the principle of virtual power, statically indeterminate systems; statically determinate truss structures, ideal truss structures, nodal point equilibrium, methods for truss force determination; friction, static friction, sliding friction, friction at joints and supports, rolling resistance; forces in cables; beam loading, force and moment vector.

Lecture notes
Übungsblätter

Literature
Sayir, M.B., Dual J., Kaufmann S., Ingenieurmechanik 1: Grundlagen und Statik, Teubner

3. Semester

Compulsory Courses

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0363-10L</td>
<td>Analysis III</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>A. Iozzi</td>
</tr>
</tbody>
</table>

Abstract
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

Content
Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates; Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Literature

For reference/complement of the Analysis I/II courses:
Christian Blatter: Ingenieur-Analysis (Download PDF)
Up-to-date information about this course can be found at:
http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0503-00L</td>
<td>Dynamics</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>G. Haller</td>
</tr>
</tbody>
</table>

Abstract
Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies Vibrations
### Objective

This course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibria and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications.

### Content

1. Motion of a single particle || Kinematics: trajectory, velocity, acceleration, inertial frame, moving frames - Forces and torques. Active- and reaction forces. - Linear momentum principle, angular momentum principle, work-energy principle - Equations of motion;  
2. Motion of systems of particles || Internal and external forces - Linear momentum principle, angular momentum principle, work-energy principle - Rigid body systems of particles; conservative systems;  
3. 3D motion of rigid bodies || Kinematics: angular velocity, velocity transport formula, instantaneous center of rotation - Linear momentum principle, angular momentum principle, work-energy principle - Parallel axis theorem. Angular momentum transport formula  

### Lecture notes

Hand-written slides will be downloadable after each lecture.

### Literature

The lecture bases on the books specified under "LITERATUR". The books 1) to 5) can be downloaded as pdf's.

4) M. Meier und P. Ermanni, Dimensionieren 1, Zürich, 2012.
5) H. Haberhauer, F. Bodenstein, Maschinenelemente, Berlin: Springer 2008

### Prerequisites / notice

Please log in to moodle (https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php), search for "Dynamics", and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.
Objective
The lecture is intended to promote critical, scientific thinking. Key concepts of Physics will be acquired, with a focus on technically relevant applications. At the end of the two semesters, students will have a good overview over the topics of classical and modern Physics.

Content
Electric and magnetic fields, current, magnetism, Maxwell’s equations, concept of light, classical optics, waves.

Lecture notes
Notes from lectures will be available (in German).

Literature
Friedhelm Kuypers
Physik fuer Ingenieure und Naturwissenschaftler

Paul A. Tipler, Gene Mosca, Michael Basler and Renate Dohmen
Physik für Wissenschaftler und Ingenieure
Spektrum Akademischer Verlag, 2009, 1636 Seiten, ca. 80 Euro.

5. Semester

Compulsory Courses Examination Block 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0261-00L</td>
<td>Engineering Tool II: Introduction to MATLAB</td>
<td>O</td>
<td>0.4 credits</td>
<td>1K</td>
<td>B. Berisha, P.Hora</td>
</tr>
</tbody>
</table>

Abstract
Introduction to MATLAB; vectors and matrices; graphics in MATLAB; calculus, differential equations; programming with MATLAB; data analysis and statistics; interpolation and polynomials. Exercises with solutions: using MATLAB commands, technical applications.

Objective
Introduction to numerical calculations with MATLAB.

Content
Introduction to MATLAB; vectors and matrices; graphics in MATLAB; calculus, differential equations; programming with MATLAB; data analysis and statistics; interpolation and polynomials. Exercises with solutions: using MATLAB commands, technical applications.

Lecture notes
Web-based tutorial:
http://www.ivp.ethz.ch/studium/vorlesungen.html

Prerequisites / notice
Der Kurs findet in einem Hörsaal statt und es stehen keine Rechner zur Verfügung. Es wird empfohlen, dass pro zwei Studierenden mindestens ein Laptop mit installiertem Matlab mitgebracht wird.

Installation Matlab:
- es funktionieren alle Versionen
- netzunabhängige Node-Lizenz (z.B. zum Download auf IDES)
- folgende Toolboxes/Features müssen installiert sein: Simulink (wird für RT1 benutzt), Curve Fitting Toolbox, Optimization Toolbox, Symbolic Toolbox, Global Optimization Toolbox

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0261-00L</td>
<td>Thermodynamics III</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>R. S. Abhari, A. Steinfeld</td>
</tr>
</tbody>
</table>

Abstract
Technical applications of engineering thermodynamics. Extension of thermodynamical fundamentals taught in Thermodynamics I and II.

Objective
Understand and apply thermodynamic principles and processes for use in a range of cycles used commonly in practice.

Content

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0103-00L</td>
<td>Fluid Dynamics II</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>P. Jenny</td>
</tr>
</tbody>
</table>

Abstract

Objective
Expand basic knowledge of fluid dynamics. Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Content

Lecture notes
Lecture notes are available (in German). (See also info on literature below.)

Literature
Relevant chapters (corresponding to lecture notes) from the textbook


Prerequisites / notice
Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0917-00L</td>
<td>Mass Transfer</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>R. Büchel, S. E. Pratsinis</td>
</tr>
</tbody>
</table>

Abstract
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Objective
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.
Content
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's
2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and
Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across
interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and
surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogeneous reversible
and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Literature

Prerequisites / notice
Three tests are offered for practicing the course material. Participation is voluntary.

401-0603-00L
Stochastics (Probability and Statistics) W 4 credits 2V+1U J. Teichmann
Abstract
This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional
probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for
normally distributed data, point estimation, and two-sample tests.

Objective
Knowledge of the basic principles of probability and statistics.

Content
Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.

Lecture notes
Lecture notes

Literature
Lecture notes

151-0573-00L
System Modeling W 4 credits 2V+2U G. Ducard, C. Onder
Abstract
Generic modeling approaches for control-oriented models based on first principles, Lagrangian formalism and experimental data. Model
parametrization, planning of experiments, linear and nonlinear estimation techniques for "gray-box" models. Analysis of linear systems,
model scaling, linearization, order reduction, and balancing. Analysis of nonlinear models.

Objective
Introduction to system modeling for control. Analysis and optimization of linear and nonlinear systems. Parameter identification. Case
studies.

Content
Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data.
Examples: mechatronic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Planning
of experiments, estimation techniques for "gray-box" models (linear and nonlinear least-squares methods). The exercises are solved in
teams. One larger case study is to be solved.

Lecture notes
The handouts in English will be sold in the first lecture.

Literature
A list of references is included in the handouts.

151-0973-00L
Fundamentals in Process Engineering W 4 credits 2V+2U P. Rudolf von Rohr, C. Müller
Abstract
Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria
for multiphase systems; introduction into mechanical process engineering and particle technology

Objective
To expand fundamentals in process engineering

Content
Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria
for multiphase systems; introduction into mechanical process engineering and particle technology

Lecture notes
script in German available

151-0575-01L
Signals and Systems W 4 credits 4G R. D'Andrea
Abstract
Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to
signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on
systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.

Objective
Master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercises.

Content
Discrete-time signals and systems. Fourier- and z-Transforms. Frequency domain characterization of signals and systems. System
identification. Time series analysis. Filter design.

Lecture notes
Lecture notes available on course website.

363-0511-00L
Managerial Economics W 4 credits 3V S. Rausch, V. Hoffmann
Abstract
Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to
optimization, the theory of consumer demand, the theory of the firm, industrial organization, decision making under uncertainty are
studied using methods of numerical analysis, statistical estimation, game theory and constrained optimization.

Objective
The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic
concepts for firm-level management decisions. The course covers a number of models and methods of analysis which are commonly
employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization,
applications of game theory to contract design and agency theory, and the theory of decision making under uncertainty focusing specifically
on long-term investment decisions. The course will include three lectures by Professor Volker Hoffman focusing on related case-studies in
management.

Literature
Mikroökonomie (Pearson Studium - Economic VWL) Gebundene Ausgabe, August 2013, Robert S. Pindyck, Dr. Daniel L. Rubinfeld.

Prerequisites / notice
Not for MSc students belonging to D-MTEC!

227-0076-00L
Electrical Engineering II W 4 credits 2V+2U J. Biela
Abstract
Signals and systems in the time and frequency domain, principle of operation and design of basic analog and digital circuits, analog-digital
conversion. Basic power electronic circuits, design of magnetic components, electromechanical energy conversion, principle of operation
and characteristics of transformers and selected rotating electrical machines.

Objective
see above

Content
Beschreibung von Signalen und Systemen im Zeit- und Frequenzbereich, Funktion grundlegender analoger und digitaler Schaltung,
Analog-Digital-Wandler. Grundlagen leistungselektronischer Konverter, Berechnung magnetischer Kreise, elektromechanische
Energieumwandlung, Funktionsprinzip von Transformatoren und ausgewählter rotierender elektrischer Maschinen.

401-0435-00L
Computational Methods for Engineering Applications W 4 credits 2V+2U S. Mishra
Abstract
The course gives an introduction to the numerical methods for the solution of ordinary and partial differential equations that play a central
role in engineering applications. Both basic theoretical concepts and implementation techniques necessary to understand and master the
methods will be addressed.

Objective
At the end of the course the students should be able to:
- implement numerical methods for the solution of ODEs (= ordinary differential equations);
- identify features of a PDE (= partial differential equation) based model that are relevant for the selection and performance of a numerical
algorithm;
- implement the finite difference, finite element and finite volume method for the solution of simple PDEs using C++;
- read engineering research papers on numerical methods for ODEs or PDEs.
Content

Initial value problems for ODE: review of basic theory for ODEs, Forward and Backward Euler methods, Taylor series methods, Runge-Kutta methods, multi-step methods, predictor-corrector methods, basic stability and consistency analysis, numerical solution of stiff ODEs.

Two-point boundary value problems: Green's function representation of solutions, Maximum principle, finite difference schemes, stability analysis.

Elliptic equations: Laplace's equation in one and two space dimensions, finite element methods, implementation of finite elements, error analysis.


Hyperbolic equations: Linear advection equation, method of characteristics, upwind schemes and their stability. Burgers equation, scalar conservation laws, shocks and rarefactions, Riemann problems, Godunov type schemes, TVD property.

Lecture notes

Script will be provided.

Literature

Chapters of the following book provide supplementary reading and are not meant as course material:


Prerequisites / notice

(Suggested) Prerequisites:
Analysis I-III (for D-MAVT), Linear Algebra, CMEA I, basic familiarity with programming in C++.

151-3207-00L

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0073-30L</td>
<td>Submersible Robot for Underwater Scanning</td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>R. Siegwart</td>
</tr>
</tbody>
</table>

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2016 with new enrolling for the same Focus-Project in FS2016.

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:
- Basis examination successfully passed
- Block 1 and 2 successfully passed

Objective

The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
- Independence, initiative, independent learning of new topic contents
- Problem structuring, solution identification in indistinct problem definitions, searches of information
- System description and simulation
- Presentation methods, writing of a document
- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

Prerequisites / notice

This Focus-Project is supervised by the following lecturers:
- Siegwart, R., ASL
- Haas, R., ASL
- Beardsley P., Disney Research Zurich

151-0073-10L

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<tr>
<th>Number</th>
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<tr>
<td>151-0073-10L</td>
<td>Remote Controlled Walking Excavator</td>
<td>W</td>
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For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:
- Basis examination successfully passed
- Block 1 and 2 successfully passed

Abstract

Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).
Objective

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- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

Prerequisites / notice

This Focus-Project is supervised by the following lecturers:
Siegwart, R., ASL
Haas, R., ASL
Fankhauser, P., ASL
Alexis, K., ASL

### Focus Projects in Manufacturing

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>151-0075-10L</td>
<td>Steer By Wire</td>
<td>W</td>
<td>0 credits</td>
<td>15A</td>
<td>K. Wegener</td>
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### Formula Student Electric - Chassis and Suspension

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<tr>
<td>151-0075-20L</td>
<td>Formula Student Electric - Chassis and Suspension</td>
<td>W</td>
<td>0 credits</td>
<td>15A</td>
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### Modularized Multi-Speed Compressor

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### Objective
The various objectives of the Focus Project are:
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- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

### Content
Several teams of 4-8 students of the ETH as well as students from other universities realize a product during two semesters. On the basis of a vision and provocative problem definition, all processes of product development are beat down close-to-reality: conception, design, engineering, simulation, draft and production. The teams are coached by experienced staff who gives them the possibility of a unique learning experience.

Innovative ideas of the research labs of the ETH, of industrial partners or students are selected and realized by the teams.

### Prerequisites
- a. Basis examination successfully passed
- b. Block 1 and 2 successfully passed

### Focus Projects in Design, Mechanics and Materials

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<tr>
<td>151-0075-40L</td>
<td>Foldable Flettner Rotor for Small Sailing Boats</td>
<td>W</td>
<td>0</td>
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<td>P. Hora</td>
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<tr>
<td>151-0079-20L</td>
<td>Exoskelett für den Cybathlon</td>
<td>W</td>
<td>0</td>
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<td>M. Meboldt</td>
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Abstract

Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

Objective

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- Presentation methods, writing of a document
- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

151-0079-50L Zurich Heart MIAA (Minimal Invasive Aortic Anastomosis)

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2016 with new enrolling for the same Focus-Project in FS2016.

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:
- a. Basis examination successfully passed
- b. Block 1 and 2 successfully passed

Abstract

Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

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- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

151-0077-10L Stretchable electronics based bladder volume sensor

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2016 with new enrolling for the same Focus-Project in FS2016.

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:
- a. Basis examination successfully passed
- b. Block 1 and 2 successfully passed

Abstract

Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

Objective

The various objectives of the Focus Project are:
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Content

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Courses Eligible for Focus Projects

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<tbody>
<tr>
<td>151-0761-00L</td>
<td>Practice Course to Focus Projects on Product Development</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Meboldt, C. R. Dietzsch, I. Goller, R. P. Haas, C. Schorno,</td>
</tr>
</tbody>
</table>
This course provides comprehensive input to ongoing focus project teams in the areas of project management, dealing with the media, suppliers and designers as well as creativity, design methodology, technical reports, and issues regarding patents.

Objective
Participants will receive tips, hints and background information from experienced tutors applicable to current projects.

Content
- Project Management
  - Creating a solid project base
  - Project planning and controlling
  - Problem solving cycle and decision taking transparent for others
- Communication
  - Public Relations in a Nutshell
  - How to acquire and manage suppliers and sponsors
  - Technical reports
- Creativity and Solution Finding
  - Creativity methodology
  - Design methodology and product validation
  - Issues regarding patents

Lecture notes
Lecture notes and documentation will be electronically available.

Prerequisites / notice
- only for students participating in a Focus Project in the same semester
- not more than 30 students

Practice Course to Focus Projects on CAD and CAE Based on Siemens NX
Number of participants limited to 30.

Only students for focus projects, 2 up to 3 students per focus project.

Abstract
This course provides comprehensive input to ongoing Focus Projects teams in the areas of CAD and CAE mit Siemens NX. Other topics can be chosen on top.

Objective
Participants will receive tips, hints and background information from experienced tutors applicable to current projects.

Content
- CAD with Siemens NX
  - 1 day of intensive training (1x8L)
  - 2 separate days of intensive training (2x8L)
- CAE mit Siemens NX
  - FreeForm-Modelling, CAE Integration in TeamCenter PDM, Design methodology

Further Topics, free choice (each 1x4L)
- Issues regarding patents
- Creativity methodology
- Technical reports
- How to acquire and manage suppliers and sponsors
- Public Relations in a Nutshell

Lecture notes
Lecture notes and documentation will be electronically available.

Prerequisites / notice
- only for students participating in a Focus Project in the same semester
- not more than 30 students
- use of Siemens NX in the corresponding Focus Project

Base Camp for Focus Projects
Das Base Camp ist eine intensive Kick Off Veranstaltung für Teilnehmer und Coaches der Fokusprojekte.

Number of participants limited to 30.

Abstract
The Base Camp is an intense kick-off event for participants and coaches of the Focus Projects. During two days, the teams actively prepare their projects and share their ideas with experienced coaches and other project teams. Based on the individual development goals of the various Focus Projects, the teams work on several design tasks.

Objective
- Getting aware of all project related aspects (problem understanding, user identification, generation of solution ideas)
- Learning about different approaches in Product Development (iteration, prototyping, testing, project management)
- Developing soft skills (presenting, giving and getting feedback, team composition and roles)
- Getting ready to start (motivation, vision, critical thinking, project plan)

Content
Die Lehrveranstaltung ist durch ein sich wiederholenden Zyklus von: input lecture - team activity - presentation & feedback charakterisiert.

Teilnehmer müssen in einem Fokusprojekt eingeschrieben oder Coach eines Fokusprojektes sein

Experimental Methods for Engineers
Number of participants limited to 30.

Abstract
The course presents an overview of measurement tasks in engineering environments. Different concepts for the acquisition and processing of typical measurement quantities are introduced. Following an initial in-class introduction, laboratory exercises from different application areas (especially in thermofluidics and process engineering) are attended by students in small groups.

Objective
- Understanding of various sensing technologies and analysis procedures.
- Study of applications in the laboratory.
- Fundamentals of scientific documentation & reporting.

Content
- Introduction to various aspects of measurement techniques, with particular emphasis on thermo-fluidic applications.
- Exposure to typical experiments, diagnostics hardware, data acquisition and processing.
- Lab reports for all attended experiments have to be submitted by the study groups.
- A final exam evaluates the acquired knowledge individually.

Lecture notes
Presentations, handouts and instructions are provided for each experiment.
Hours
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic

P. Jenny
Lecture notes are available
Studies on Mechatronics

Focused Study: Selected Topics in Research and Application in Energy, Flows and Processes ★ Exclusive for D-MAVT Bachelor-students of Focus Specialization "Energy, Flows and Processes". Please discuss with your focus coordinator.

Abstract
Independent studies on a defined field in energy, flows, and processes.

Objective
Independent studies on a defined field in energy, flows, and processes.

Literature

W. 11A

Contents
1. Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling

2. Properties of laminar, transitional and turbulent flows.


5. Scalings, homogeneous isotropic turbulence, energy spectrum.


7. Wall-bounded turbulent flows.

8. Turbulent flow computation and modeling.

Lecture notes
Lecture notes are available

Literature

151-0973-00L Fundamentals in Process Engineering W 4 credits 2V+2U P. Rudolf von Rohr, C. Müller

Abstract
Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology

Objective
To expound fundamentals in process engineering

Content
Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology

Lecture notes
script in German available

151-0973-00L Fundamentals in Process Engineering W 4 credits 2V+2U P. Rudolf von Rohr, C. Müller

Abstract
Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology

Objective
To expound fundamentals in process engineering

Content
Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology

Lecture notes
script in German available

151-0917-00L Mass Transfer W 4 credits 2V+2U R. Büchel, S. E. Pratsinis

Abstract
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Objective
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

151-0917-00L Mass Transfer W 4 credits 2V+2U R. Büchel, S. E. Pratsinis

Abstract
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Literature

Prerequisites / notice

151-0109-00L Turbulent Flows W 4 credits 2V+1U P. Jenny

Abstract
- Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scalings, Homogeneous isotropic turbulence, correlations, Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence: Channel and boundary layer - Computation and modelling of turbulent flows

Objective
Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling

Content
- Properties of laminar, transitional and turbulent flows.
- Origin and control of turbulence. Instability and transition.
- Statistical description, averaging, equations for mean and fluctuating quantities, closure problem.
- Scalings, homogeneous isotropic turbulence, energy spectrum.
- Turbulent free shear flows. Jet, wake, mixing layer.
- Wall-bounded turbulent flows.
- Turbulent flow computation and modeling.

Lecture notes
Lecture notes are available

Literature

151-0135-00L Focused Study: Selected Topics in Research and Application in Energy, Flows and Processes ★ Exclusive for D-MAVT Bachelor-students of Focus Specialization "Energy, Flows and Processes". Please discuss with your focus coordinator.

Abstract
Independent studies on a defined field in energy, flows, and processes.

Objective
Independent studies on a defined field in energy, flows, and processes.

Mechatronics ★ ★ ★

Number
Title
Type
ECTS
Hours
Lecturers

151-0640-00L Studies on Mechatronics ★
The following professors can be chosen and please contact the professor directly:
R. D'Andrea, C. Daraio, J. Dual, R. Gassert, C. Onder, C.

Overview of Mechatronics topics and study subjects. Identification of minimum 10 pertinent refereed articles or works in the literature in consultation with supervisor or instructor. After 4 weeks, submission of a 2-page proposal outlining the value, state-of-the-art and study plan based on these articles. After feedback on the substance and technical writing by the instructor, project commences.

The students are familiar with the challenges of the fascinating and interdisciplinary field of Mechatronics and Mikrosystems. They are introduced in the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

The students work independently on a study of selected topics in the field of Mechatronics or Microsystems. They start with a selection of scientific papers to continue literature research. The results (e.g. state-of-the-art, methods) are evaluated with respect to predefined criteria. Then the results are presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

Lecture notes will be available

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0575-01L</td>
<td>Signals and Systems</td>
<td>4</td>
<td>R. D’Andrea</td>
</tr>
<tr>
<td>376-1504-00L</td>
<td>Physical Human Robot Interaction (pHRI)</td>
<td>4</td>
<td>R. Gassert, O. Lamercy, R. Riener</td>
</tr>
</tbody>
</table>

Number of participants limited to 26.

Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.

Master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercises.


Lecture notes are available on course website.

http://www.relab.ethz.ch/education/courses/phri.html

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and develop safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical system;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://eduhaptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.
Literature


Prerequisites / notice

The registration is limited to 26 students
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/pHRI

151-0621-00L

Microsystems Technology

W
6 credits
4G
C. Hierold, M. Haluska

Abstract

Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and -devices by a sequence of defined processing steps (process flow).

Objective

Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystem devices by the combination of unit process steps (= process flow).

Content

- Introduction to microsystems technology (MST) and micro electro mechanical systems (MEMS).
- Basic silicon technologies: Thermooxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.
- Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system architecture and computation.

Lecture notes

Handouts (available online)

- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O.Paul: Microsystem Technology
- G. Kovacs: Micromachined Transducer Sourcebook

Prerequisites / notice

Prerequisites: Physics I and II

227-0113-00L

Power Electronics

W
6 credits
4G
J. W. Kolar

Abstract

Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Objective

Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Content


Lecture notes

Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

Prerequisites / notice

Prerequisites: Basic knowledge of electric circuit analysis and signal theory.

227-0517-00L

Electrical Drive Systems II

W
6 credits
4G
P. Steimer, G. Scheuer, C. A. Stulz

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 925 of 1432
Abstract
In the course "Drive System II" the power semiconductors are repeated. The creation of converters based on the combination of switches/cells and based topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions. Further topics are the control of the synchronous machine, of line-side converters and issues with converter-fed machines

Objective
The students establish a deeper understanding in regards of the design of the main components of an electrical drive system. They establish knowledge on the most important interaction with the grid and the machine and their related high dynamic control.

Content
Converter topologies (switch or cell based), multi-pulse diode rectifiers, system aspects of transformer and electrical machines, 3-level inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent magnet machines), control of line-side converters, reflection effects with power cables, winding induction and bearing stress. Field trip to ABB Semiconductors.

Lecture notes
Skript is sold at the beginning of the lectures or can be downloaded from Ilias

Literature
Skript of lecture; References in skript to related technical publications and books

Prerequisites / notice
Prerequisites: Electrical Drive Systems I (recommended), Basics in electrical engineering, power electronics, automation and mechatronics

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Type</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>4</td>
<td>W</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
<tr>
<td>151-0138-00L</td>
<td>Focused Study: Selected Topics in Research and Application in Mechatronics</td>
<td>1</td>
<td>W</td>
<td>2A</td>
<td>B. Nelson</td>
</tr>
<tr>
<td>151-0509-00L</td>
<td>Microscale Acoustofluidics</td>
<td>4</td>
<td>W</td>
<td>3G</td>
<td>J. Dual</td>
</tr>
</tbody>
</table>

Microsystems and Nanoscale Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0619-00L</td>
<td>Introduction to Nanoscale Engineering</td>
<td>W</td>
<td>5</td>
<td>2V+3P</td>
<td>S. E. Pratsinis, D. J. Norris, A. Teleki Sotiriou, K. Wegner</td>
</tr>
<tr>
<td>151-0643-00L</td>
<td>Studies on Micro and Nano Systems</td>
<td>W*</td>
<td>5</td>
<td>11A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Notes:
- "Hands-on" research project including project presentations and reporting
- The class gives an overview of fundamental concepts in nanoscale engineering. Mobility of small objects, interacting forces, surface tensions and wetting phenomena are some of the physical phenomena investigated. These will be applied to the description of formation and growth of nanoparticles and thin films as well as nanofabrication technologies.
- The goal of the lecture is to familiarize the students with the basic phenomena occurring on the nanometer scale, thereby illustrating the links to physics, chemistry, materials science, and biology. A further objective is to demonstrate the development of technologies and processes based on or including nanoscale phenomena.
- The students get familiarized with the challenges of the fascinating and interdisciplinary field of Micro- and Nanosystems. They are introduced to the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

Please contact one of the following professors directly:

Autumn Semester 2015
Objective
The students get familiarized with the challenges of the fascinating and interdisciplinary field of Micro- and Nanosystems. They are introduced to the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

Content
Students work independently on a study of selected topics in the field of Micro- and Nanosystems. They start with a selection of scientific papers, and continue with an independent literature research. The results (e.g. state-of-the-art, methods) are evaluated with respect to predefined criteria. Then the results are presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

Literature
Literature will be provided

<table>
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<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td></td>
<td>B. Nelson</td>
</tr>
<tr>
<td>Abstract</td>
<td>Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The objective of this course is to expose students to the fundamentals of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.</td>
<td></td>
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</tbody>
</table>
| Content     | Main topics of the course include:  
- Scaling laws at micro/nano scales  
- Electrostatics  
- Electromagnetism  
- Low Reynolds number flows  
- Observation tools  
- Materials and fabrication methods  
- Applications of biomedical microrobots |
| Lecture notes | The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically. |
| Prerequisites / notice | The lecture will be taught in English. |

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<tr>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0911-00L</td>
<td>Introduction to Plasmonics</td>
<td>W</td>
<td>4</td>
<td></td>
<td>D. J. Norris</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics. Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.</td>
<td></td>
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</tbody>
</table>
| Content     | Fundamentals of Plasmonics  
- Basic electromagnetic theory  
- Optical properties of metals  
- Surface plasmon polaritons on surfaces  
- Surface plasmon polariton propagation  
- Localized surface plasmons  
Applications of Plasmonics  
- Waveguides  
- Extraordinary optical transmission  
- Enhanced spectroscopy  
- Sensing  
- Metamaterials |
| Lecture notes | Class notes and handouts |
| Prerequisites / notice | Physics I, Physics II |

---|---
Objective | Deepened discussion on the machining processes and their optimisation. Outlook for additional areas such as NC-Technique, dynamics of processes and machines, chatter as well as process monitoring.
Content | Deepened insight in the machining processes and their optimisation, chip removal by undefined cutting edge, such as grinding, honing and lapping, machining processes without cutting edges, such as EDM, ECM, outlook in additional areas as NC-technique, machine- and process dynamics including chatter and process monitoring.
Lecture notes | yes
Prerequisites / notice | Prerequisites: Recommendation: Lecture 151-0700-00L Manufacturing elective course in the 4th semester. Language: Help for English speaking students on request as well as english translations of slides shown.

| 151-0733-00L | Forming Technology III - Forming Processes | O | 4 credits | 2V+2U | P. Hora
---|---|---|---|---|---
Abstract | The lecture teaches on the basic knowledge of major processes in sheet metal, tube and bulk metal forming technologies. In particular it focuses on fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.
Objective | Acquaintance with forming processes. Determination of forming processes. Interpretation of forming manufacturing
Content | The study of metal working processes: sheet metal forming, folding die cutting, cold bulk metal forming, ro extrusion, plunging, open die forging, drop forging, milling; active principle; elementary methods to estimate stress and strain; fundamentals of process design; manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.
Lecture notes | ja
Prerequisites / notice | Recommended to the focus production engineering. Majority of lecturers from the industry.

| 151-0717-00L | Mechanical Production: Assembly, Joining and Coating Technology | W | 4 credits | 2V+1U | P. Kuster, V. H. Derflinger, F. Durand, P. Jousset
---|---|---|---|---|---
Abstract | Understanding of the complexity of the assembly process as well as its meaning as success and cost factor. The assembly with the different aspects of adding, moving, adjusting, controlling parts etc.. Adding techniques; solvable and unsolvable connections. Assembly plants. Coating techniques and their tasks, in particular corrosion protection.
Objective | To understand assembly in its full complexity and its paramount importance regarding cost and financial success. An introduction into a choice of selected joining and coating techniques.
Content | Assembly as combination of several classes of action like, e.g., joining, handling, fine adjustments, etc. Techniques for joining objects temporarily or permanently. Assembly systems. Coating processes and their specific applications, with particular emphasis on corrosion protection.
Lecture notes | Yes
Prerequisites / notice | Recommended to the focus production engineering. Majority of lecturers from the industry.

| 151-0731-00L | Forming Technology I - Basic Knowledge | W | 4 credits | 2V+2U | P. Hora
---|---|---|---|---|---
Abstract | The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is: Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.
Objective | Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and its industrial applications. This includes, together with the acquirements of the most important forming processes, the characterization of plastic material behavior and manufacturing limits.
Content | Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plasto-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology. Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.
Lecture notes | ja

| 151-0719-00L | Quality of Machine Tools - Dynamics and Metrology at Micro and Submicro Level | W | 4 credits | 2V+1U | W. Knapp, F. Kuster
---|---|---|---|---|---
Abstract | The course "Machine tool metrology" deals with the principal design of machine tools, their spindles and linear axes, with possible geometric, kinematic, thermal and dynamic errors of machine tools and testing these errors, with the influence of errors on the workpiece (error budgeting), with testing of drives and numerical control, as well as with checking the machine tool capability.
Objective | Knowledge of:
- principal design of machine tools
- errors of linear and rotational axes and of machine tools,
- influence of errors on the workpiece (error budgeting)
- dynamics of mechanical systems
- geometric, kinematic, thermal, dynamic testing of machine tools
- test uncertainty
- machine tool capability
Content | Metrology for production, machine tool metrology
- basics, like principal machine tool design and machine tool coordinate system
- principal design and errors of linear and roational axes
- error budgeting, influence of machine errors on the workpiece
- geometric and kinematic testing of machine tools
- reversal measurement techniques, multi-dimensional machine tool metrology
- thermal influences on machine tools and testing these influences
- test uncertainty, simulation
- dynamics of mechanical systems, dynamic error sources
- machine tool dynamics and the engineering tools modal analysis and finite element method (FEM)
- testing of drives and numerical control
- machine tool capability
Lecture notes | Documents are provided during the course. English handouts available on request.
Prerequisites / notice | Exercises in the laboratories and with the machine tools of the institute for machine tools and manufacturing (IWF) provide the practical background for this course.

| 151-0703-00L | Operational Simulation of Production Lines | W | 4 credits | 2V+1U | P. Acél
---|---|---|---|---|---
Abstract | The student learns the application of the event-driven and computer-based simulation for layout and operational improvement of production facilities by means of practical examples.
### Objective
The student learns the right use of (Who? When? How?) of the event-driven and computer-based simulation in the illustration of the operating procedures and the production facilities. Operating simulation in the productions, logistic and scheduling will be shown by means of practical examples. The student should make his first experiences in the use of computer-based simulation.

### Content
- Application and application areas of the event-driven simulation
- Exemplary application of a software tool (Technomatrix-Simulation-Software)
- Internal organisation and functionality of simulation tools
- Procedure for application: optimizing, experimental design planning, analysis, data preparation
- Controlling philosophies, emergency concepts, production in sequence, line production, rescheduling
- Application on the facilities projecting

### Lecture notes
The knowledge is enhanced by practice-oriented exercises and an excursion. A guest speaker will present a practical example.

### Prerequisites
Recommended for all Bachelor-Students in the 5th semester and Master-Students in the 7th semester.

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

### Literature

### Prerequisites
If we will have a large number of students, two dates for the exercises will be offered.

### Objective
The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the non linear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the non linear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the non linear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model with the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

### Content
- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

### Lecture notes
Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

### Prerequisites
Prerequisites: Basic knowledge of electric circuit analysis and signal theory.
### Biomedical Engineering

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>376-0021-00L</td>
<td>Introduction to Biomedical Engineering I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>R. Müller, P. Christen, J. G. Snedeker, M. Zenobi-Wong</td>
</tr>
<tr>
<td>151-0619-00L</td>
<td>Introduction to Nanoscale Engineering</td>
<td>W</td>
<td>5</td>
<td>2V+3P</td>
<td>S. E. Pratsinis, D. J. Norris, A. Teleki Sotiriou, K. Wegner</td>
</tr>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Pouliakos, A. Ferrari</td>
</tr>
</tbody>
</table>

#### Abstract

With your focus coordinator.

#### Objective

- Independent studies on a defined field in manufacturing and reporting.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>151-0723-00L</td>
<td>Manufacturing of Electronic Devices</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Kunz, A. Gubler, R.D. Moryson, F. Reichert</td>
</tr>
</tbody>
</table>

#### Content

- The lecture follows the value added process sequence of electric and electronic components. It contains: Development of electric and electronic circuits, design of electronic circuits on printed circuit boards as well as in hybrid technology, integrated test technology, planning of production lines, production of highly integrated electronic on a wafer as well as recycling.

#### Abstract

Nothing works without electronics! Typical products in mechanical engineering such as machine tools, as well as any kind of vehicle contain a significant amount of electric or electronic components of more than 60%. Thus, it is important to master the value added process sequence for electronic and electronic components.

#### Objective

- Knowledge about the value added process sequence for electronics manufacturing, planning of electric and electronic product as well as their production, planning of production lines, value added process sequence for photovoltaics.

#### Literature

- Slides of the lectures, relevant journal papers and users manuals will be provided.
- Various books will be recommended covering the topics discussed in class
- Course in continuum mechanics (mandatory), finite element method (recommended)

#### Prerequisites / notice

- Help for English speaking students on request.
- The lecture notes are handed out during the individual lessons (CHF 20.-).
- The lecture is partly given by experts from industry. It is supplemented by an excursion to one of the industry partners.

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### Introduction to Biomedical Engineering

#### Number

376-0021-00L

#### Title

Introduction to Biomedical Engineering I

#### Type

W

#### ECTS

4

#### Hours

3G

#### Lecturers

- R. Müller
- P. Christen
- J. G. Snedeker
- M. Zenobi-Wong

#### Abstract

Introduction to biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering.

#### Objective

Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.

#### Content

- Tissue and Cellular Biomechanics
- Molecular Biomechanics
- Biopolymers
- Computational Biomechanics
- Biomaterials
- Tissue Engineering
- Radiation and Radiographic Imaging
- Diagnostic Ultrasound Imaging
- Magnetic Resonance Imaging
- Biomedical Optics and Lasers

#### Literature

- Academic Press

#### Prerequisites / notice

- Various books will be recommended covering the topics discussed in class
- Course in continuum mechanics (mandatory), finite element method (recommended)

---

### Introduction to Nanoscale Engineering

#### Number

151-0619-00L

#### Title

Introduction to Nanoscale Engineering

#### Type

W

#### ECTS

5

#### Hours

2V+3P

#### Lecturers

- S. E. Pratsinis
- D. J. Norris
- A. Teleki Sotiriou
- K. Wegner

#### Abstract

The class gives an overview of fundamental concepts in nanoscale engineering. Mobility of small objects, interacting forces, surface tensions and wetting phenomena are some of the physical phenomena investigated. These will be applied to the description of formation and growth of nanoparticles and thin films as well as nanofabrication technologies.

#### Objective

- The goal of the lecture is to familiarize the students with the basic phenomena occurring on the nanometer scale, thereby illustrating the links to physics, chemistry, materials science, and biology. A further objective is to demonstrate the development of technologies and processes based on or including nanoscale phenomena.

#### Content

- Nanoparticle building blocks for device fabrication
- Particle size distributions and size selection
- Nanoparticle formation
- Forces between small objects
- Control of nanoparticle properties in the gas-phase
- The electric double layer
- Characterization of nanomaterials
- Microscopes and tools for nanoscale objects
- Thin film formation
- Nanofabrication
- Small "hands-on" research project including project presentations and reporting

#### Prerequisites / notice

- Various books will be recommended covering the topics discussed in class
- Course in continuum mechanics (mandatory), finite element method (recommended)
### 151-0604-00L Microsystems Technology

**Objective**
Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.

**Content**
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

**Lecture notes / literature**
Script as well as additional material in the form of hand-outs will be distributed.

**Prerequisites / notice**
The lecture will be taught in English.

<table>
<thead>
<tr>
<th>151-0621-00L</th>
<th>Microrobotics</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>B. Nelson</th>
</tr>
</thead>
</table>

**Abstract**
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Lecture notes / literature**
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

**Prerequisites / notice**
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

### 151-0604-00L Physical Human Robot Interaction (pHRI)

**Objective**
By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1. Identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2. Compare and select mechatronic components that optimally fulfill the defined design requirements;
3. Derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4. Design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5. Characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6. Investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

**Content**
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

**Objective**
The objective of this course is to give an introduction to the fundamentals of physical human-robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1. Identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2. Compare and select mechatronic components that optimally fulfill the defined design requirements;
3. Derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4. Design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5. Characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6. Investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

**Lecture notes**
This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, motor sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical features will be implemented in a haptic system based on the haptic paddle (http://eduhaptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

**Lecture notes**
Will be distributed through the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

**Literature**
- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O.Paul: Microsystem Technology
- G. Kovacs: Micromachined Transducer Sourcebook

**Prerequisites / notice**
Prerequisites: Physics I and II

**376-1504-00L Physical Human Robot Interaction (pHRI)  ■**

**Objective**
Number of participants limited to 26.

This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

The objective of this course is to give an introduction to the fundamentals of physical human-robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1. Identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2. Compare and select mechatronic components that optimally fulfill the defined design requirements;
3. Derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4. Design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5. Characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6. Investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

**Content**
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

The objective of this course is to give an introduction to the fundamentals of physical human-robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

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6. Investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

**Lecture notes**
Will be distributed through the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

**Literature**
- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O.Paul: Microsystem Technology
- G. Kovacs: Micromachined Transducer Sourcebook

**Prerequisites / notice**
Prerequisites: Physics I and II

http://www.relabor.ethz.ch/education/courses/phri.html
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the

Continuum Mechanics 1

Handouts can be accessed online.


Prerequisites / notice

The registration is limited to 26 students.

There are 4 credit points for this lecture.

The lecture will be held in English.

The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/pHRI

Literature

151-0524-00L

Continuum Mechanics 1

W 4 credits 2V+1U E. Mazza

The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

Objective

Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

Content


Lecture notes

yes

376-1714-00L

Biocompatible Materials

W 4 credits 3G K. Manuira, J. Möller, M. Zenobi-Wong

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective

The class consists of three parts:

1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.

2. The concept of biocompatibility.

3. Introduction into methodology used in biomaterials research and application.

Content

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications and tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes

Handouts can be accessed online.

Literatur


(available online via ETH library)

Handouts provided during the classes and references therein.

227-0385-10L

Biomedical Imaging

W 6 credits 5G S. Kazerke, U. Moser, K. P. Prüssmann, M. Rudin

New course. Not to be confused with 227-0385-00L of fall 2014.

Abstract

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.
### Management, Technology, and Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0445-00L</td>
<td>Logistics, Operations and Supply Chain Management</td>
<td>W+</td>
<td>3</td>
<td>2</td>
<td>P. Schönsleben, E. Scherer Casanova</td>
</tr>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W+</td>
<td>3</td>
<td>3G</td>
<td>F. Schweitzer, P. Mavrodiev</td>
</tr>
<tr>
<td>376-0203-00L</td>
<td>Movement and Sport Biomechanics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Taylor, R. List, S. Lorenzetti</td>
</tr>
</tbody>
</table>

#### Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

#### Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

#### Lecture notes
Lecture notes and handouts

#### Literature
Webb A, Smith N.B. Introduction to Medical Imaging; Physics, Engineering and Clinical Applications; Cambridge University Press 2011

### Systems Dynamics and Complexity

**Abstract**
Finding solutions: what is complexity, problem solving cycle.

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

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

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

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

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

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

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

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

**Logistics, Operations and Supply Chain Management I**

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

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

Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Strategic and tactical concepts in logistics, operations, and supply chain management: Conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the MRP II / ERP concept: business processes and methods; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.

This book also serves as textbook for LOS II (spring term) as well as ERP and SCM software systems (autumn term). In addition powerpoint-handouts and documents for case studies.

Sales at 17.9.15, from 12:45, before and during brakes of the first lecture.

As for the lecture of the 3rd week (BEMAD, a much-liked Business Engineering and Management Ability Development game), this lecture (of Oct. 1) will follow a specific schedule in specific rooms. The schedule will be presented at Sept. 17 during the 1st lecture.

Due to the big number of students, about half of the students will play this game, instead of Oct. 1, at Friday afternoon, Oct. 2. Please be available. Thank you for your help in this matter.

**Prerequisites / notice**

As for the lecture of the 3rd week (BEMAD, a much-liked Business Engineering and Management Ability Development game), this lecture (of Oct. 1) will follow a specific schedule in specific rooms. The schedule will be presented at Sept. 17 during the 1st lecture.

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book: N. Gregory Mankiw and Mark P. Taylor (2014), "Microeconomics", 3rd edition, South-Western Cengage Learning.

Complementatory:

**Course**: Principles of Microeconomics 363-0503-00L

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>M. Filippini</th>
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</table>

**Objective**
The course introduces basic principles, problems and approaches of microeconomics.

Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

**Literature**

The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book: N. Gregory Mankiw and Mark P. Taylor (2014), "Microeconomics", 3rd edition, South-Western Cengage Learning.

Complementory:

**Course**: Principles of Macroeconomics 363-0565-00L

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>J.E. Sturm</th>
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</table>

**Objective**
The course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation. What significance do international economic relations have for Switzerland?

**Literature**
The course webpage (to be found at http://www.kof.ethz.ch/en/events/teaching/) contains announcements, course information and lecture slides.


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

**Course**: Discovering Management 351-0778-00L


**Objective**
Enter level course in management for BSc, MSc and PHD students at all levels not belonging to D-MTEC. This course can be complemented with Discovering Management (Exercises) 351-0778-01.

**Abstract**
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.
Discovering Management offers an integrated learning system, which combines in an innovate format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

<table>
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<tr>
<th>Objective</th>
<th>Content</th>
<th>Prerequisites / notice</th>
</tr>
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<tbody>
<tr>
<td>Discovering Management is designed to broaden the participant's understanding of the principles of entrepreneurial management; emphasizing the interdependence of various specialties in the development and management of a firm. For this reason, the lectures are structured on the basis of a coherent business model and will be presented by the respective area specialists at D-MTEC. The lectures broaden the view and the understanding of technology by interlinking it with society. Corporate sustainability, for example, introduces economic, ecological and social issues that are relevant to all engineering disciplines. Practical examples stimulate the students to assess these issues and be aware of their responsibilities as engineers. Technology and innovation management, to mention a second example, focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students' ability to see the business and social consequences of their 'technical' decisions. Critical skills will be trained by the case study exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant's appreciation for the complex tasks companies deal with. Discovering Management attempts to overcome the limitations of traditional teaching curricula of management in technical universities, which often merely focus on transferring specific skills to students, e.g. planning or forecasting. In response to the new challenges for entrepreneurial decision-making, students will be offered the opportunity to actively engage in an advanced business game simulation; a business game that establishes a link between business management theory and business management in practice. The simulation presents a realistic model of a company and provides participants with the opportunity to quickly gain the lasting effects of practical experience in a risk-free environment. All this provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyze the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.</td>
<td>The lectures for Discovering Management are designed to broaden the participant's understanding of the principles of entrepreneurial management; emphasizing the interdependence of various specialties in the development and management of a firm. For this reason, the lectures are structured on the basis of a coherent business model and will be presented by the respective area specialists at D-MTEC. The lectures broaden the view and the understanding of technology by interlinking it with society. Corporate sustainability, for example, introduces economic, ecological and social issues that are relevant to all engineering disciplines. Practical examples stimulate the students to assess these issues and be aware of their responsibilities as engineers. Technology and innovation management, to mention a second example, focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students' ability to see the business and social consequences of their 'technical' decisions. Critical skills will be trained by the case study exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant's appreciation for the complex tasks companies deal with. Discovering Management attempts to overcome the limitations of traditional teaching curricula of management in technical universities, which often merely focus on transferring specific skills to students, e.g. planning or forecasting. In response to the new challenges for entrepreneurial decision-making, students will be offered the opportunity to actively engage in an advanced business game simulation; a business game that establishes a link between business management theory and business management in practice. The simulation presents a realistic model of a company and provides participants with the opportunity to quickly gain the lasting effects of practical experience in a risk-free environment. All this provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyze the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.</td>
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</table>
1. Modelling path dependence and formation of standards
   - Why do clocks go clockwise? Why do people in most nations drive on the right? Why do nearly all computer keyboards have the QWERTY layout, even though it is more inefficient compared to DVORAK? It turns out that many real-world processes are path dependent, i.e., small random events early in their history determine the ultimate end state, even when all end states are equally likely at the beginning. Students will learn how to model such processes, to understand the feedback mechanisms that lead to path dependence. As a case in point, we will study the ‘war’ between the Betamax and the VHS standards.

2. Optimal migration as promoter of cooperation
   - Mechanisms to promote cooperative behaviour is a vibrant research topic in various fields - economics, evolutionary biology and management science to name but a few. Students will be introduced to one such mechanism - migration. They will develop and analyse a macroscopic model to study how the rate of migration affects the long-term cooperation rate in a population.

3. Information transfer
   - Information flow in a social system (e.g. about the location of resources or appearance of a competitor) is an important component of group living. For example, it is well known that ants can achieve remarkable feats in finding an optimal route to a food patch through pheromone trails. The goal of this study case is to model information transfer in such systems by investigating the dynamics of trail formation in ants. The students will learn that the complexity in navigating to a food source may nevertheless be explained as a simple dynamical system with one control parameter only.

4. Decisions in social societies
   - In many situations individuals have to decide between two or more options. Such decisions often have a profound impact on the system as a whole, especially regarding group cohesion. Group cohesion is preferred, as individuals can benefit from living in groups, yet it may not be the underlying reason behind individual choices. In this case, students will develop and extend a macroscopic model of an animal social system faced with a decision to choose a new home, and identify the conditions which promote group cohesion versus group splitting.

5. Antigenic variation of HIV
   - One of the characteristic traits of HIV is that a host can be a carrier and a transmitter of the virus without experiencing symptoms for up to 10 years. This case is concerned with finding the mechanism of HIV disease progression. The students will develop a general population-based model for the interaction of an infectious agent with the host immune system. The model is applicable to a variety of infectious agents, ranging from acute lethal infections to chronic illness. Through analysing and simulating the model, the students will understand how the HIV virus interacts with the host and how the mutation rate of the virus is ultimately responsible for this long asymptomatic period.

6. Compartmental models in epidemiology
   - Many diffusive processes in social systems, such as epidemics, can be understood as a result of the interaction between a few groups (compartments) of individuals. The most common example is to divide a population into those who are susceptible (S), those who have never been infected (I), and those who have recovered (R) and are immune, and to model their interactions. These so called SIR models find wide application in studying non-biological diffusive processes, e.g. spread of technological innovations, fads, internet memes etc. In this study case, students will become familiar with the basic components of an SIR model and the conditions under which a disease can cause the outbreak of an epidemic. Students will extend the basic model to investigate more realistic scenarios relevant to e.g. different vaccination strategies.

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### Content

1. Modelling path dependence and formation of standards
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   - One of the characteristic traits of HIV is that a host can be a carrier and a transmitter of the virus without experiencing symptoms for up to 10 years. This case is concerned with finding the mechanism of HIV disease progression. The students will develop a general population-based model for the interaction of an infectious agent with the host immune system. The model is applicable to a variety of infectious agents, ranging from acute lethal infections to chronic illness. Through analysing and simulating the model, the students will understand how the HIV virus interacts with the host and how the mutation rate of the virus is ultimately responsible for this long asymptomatic period.

6. Compartmental models in epidemiology
   - Many diffusive processes in social systems, such as epidemics, can be understood as a result of the interaction between a few groups (compartments) of individuals. The most common example is to divide a population into those who are susceptible (S) to a disease, those who are infected (I), and those who have recovered (R) and are immune, and to model their interactions. These so called SIR models find wide application in studying non-biological diffusive processes, e.g. spread of technological innovations, fads, internet memes etc. In this study case, students will become familiar with the basic components of an SIR model and the conditions under which a disease can cause the outbreak of an epidemic. Students will extend the basic model to investigate more realistic scenarios relevant to e.g. different vaccination strategies.
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear constitutive models.

Objective

Content
The study of metal working processes: sheet metal forming, folding die cutting, cold bulk metal forming, ro extrusion, plunging, open die forging, drop forging, milling; active principle; elementary methods to estimate stress and strain; fundamentals of process design; manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.

Lecture notes
ja

Design, Mechanics and Materials

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0360-00L</td>
<td>Procedures for the Analysis of Structures</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>G. Kress</td>
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<tr>
<td>Objective</td>
<td>Basic principles applied in structural mechanics. Introduction to the theories of planar structures. Development of an understanding of the relationship between material properties, structural theories and design criteria.</td>
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<tr>
<td>Content</td>
<td>Teams of 2 to 4 students have to design, size, and manufacture a lightweight structure complying with given specifications. A prototype as well as an improved component will be tested and assessed regarding to design and to structural mechanical criteria.</td>
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<tr>
<td>Lecture notes</td>
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</table>

| 151-0364-00L   | Lightweight Structures Laboratory                | W    | 4     | 5A    | M. Zogg, P. Ermanni |
| Abstract       | Teams of 2 to 4 students have to design, size, and manufacture a lightweight structure complying with given specifications. A prototype as well as an improved component will be tested and assessed regarding to design and to structural mechanical criteria. To develop the skills to identify and solve typical problems of the structure mechanics on a real application. Other important aspects are to foster team work and team spirit, to link theoretical knowledge and practice, to gather practical experiences in various fields related to lightweight structures such as design, different CAE-methods and structural testing. |
| Objective      | To develop the skills to identify and solve typical problems of the structure mechanics on a real application. Other important aspects are to foster team work and team spirit, to link theoretical knowledge and practice, to gather practical experiences in various fields related to lightweight structures such as design, different CAE-methods and structural testing. |
| Content        | The task of each team (typically 2-4 students) is the realization of a load-carrying structure with selected materials. The teams are free to develop and implement their own ideas. In this context, specified requirements include information about loads, interface to the surrounding structures. The project is structured as described below: - Concept development - design of the component including FEM simulation and stability checks - manufacturing and structural testing of a prototype - manufacturing and structural testing of an improved component - Report |
| Lecture notes  | The project work is supported by selected teaching units. |

| 151-0731-00L   | Forming Technology I - Basic Knowledge          | W    | 4     | 2V+2U | P. Hora          |
| Abstract       | The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is: Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure. |
| Objective      | Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure. |
| Content        | Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plasto-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology. Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery. |
| Lecture notes  | ja                                               |

| 151-0524-00L   | Continuum Mechanics 1                            | W    | 4     | 2V+1U | E. Mazza         |
| Abstract       | The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments. |
| Objective      | Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models. |
| Lecture notes  | yes                                              |

| 151-3203-00L   | Grand Challenges in Engineering Design           | W    | 1     | 3S    | P. Ermanni, M. Meboldt, K. Shea |
| Abstract       | The course is structured in three main blocks, each of them addressing a specific grand challenge in engineering design. Each block is composed of an introductory lecture and two to three invited talks, considering a good mix between speakers coming from academia and industry. Each talk is introduced and moderated by the students. |
| Objective      | The aim of the course is to introduce students to the engineering design research and practice in a multitude of Mechanical Engineering disciplines and convey knowledge from both academia and industry about state of the art methods, tools and processes. |

The students are exposed to a variety of topics in the field of Engineering Design. Topics are bundled in three main grand challenges and include an introductory lecture held by one of the responsible Professors and 2-3 invited talks of 45 min. each, addressing specific issues. The success of the course is largely dependent on active involvement of the students. Accordingly, a small group of students (1-3) is asked to introduce and moderate each external talk. The group will therefore gather adequate information about the speaker and topic, read and synthesize relevant documents and scientific papers, prepare questions to motivate the interaction with the audience and summarize, at the end of the lecture, the discussed points and outcome.

151-3201-00L Studies on Engineering Design W 3 credits 6A C. Shea, P. Ermanni, M. Meboldt

Abstract
This course introduces students to the exciting world of Engineering Design research, which crosses disciplines and requires a variety of skills. Each student identifies a topic in Engineering Design for further investigation, either based on those proposed or a new, agreed topic. Students gain their first knowledge of Engineering Design research and carry out their first, independent scientific study. Students learn how to read scientific literature and critically analyze and discuss them, gain hands-on experience in the area and learn how to document their work concisely through a report and short presentation.

Objective
Students identify 5-10 journal articles, or scientifically equivalent, in consultation with the supervisor and can define a small, related project in the area to gain hands-on experience. In the beginning of the semester, students develop with the supervisor a 2-page proposal outlining the objectives of the study, tasks to be carried out and a brief time plan for the work. Once agreed, the project starts resulting in a report combining the state-of-the-art literature review and project results, if carried out.

Content
The students work independently on a study of selected topics in the field of Engineering Design. They start with a selection of the topic, identify scientific papers for the literature research and can define a small, related project. The results (e.g. state-of-the-art literature review and small project results where defined) are evaluated with respect to predefined criteria.

Prerequisites / notice
Students take this course in parallel to the Lecture "Grand Challenges in Engineering Design". A general meeting will be held in the beginning of the semester to propose topics for the studies. Studies are carried out individually and can be the pre-study for a Bachelor thesis.

151-0511-00L Mechanics of Nano- and Micro-Materials W 4 credits 2V+1U C. Daraio

Abstract
The course provides an introduction to the mechanics of nano- and micro-materials and devices, in the quasistatic and dynamic domains. It reviews scale effects in materials, surveys available characterization techniques and describes the effects of surfaces and microscale contacts. Recent applications of nano- and micro-materials in engineering systems will be discussed.

Objective
Learn the fundamental mechanical properties of nano- and micro-system. Understand the effects of scales on the response of materials. Explore applications and devices exploiting the response of materials at small scales.

Content
Slides and notes from the course will be provided.

Literature
Relevant articles and reading materials will be provided. Various books will be recommended pertaining to the topics covered.

Prerequisites / notice
Mechanics I, II, III

151-3209-00L Engineering Design Optimization W+ 4 credits 4G K. Shea, T. Stankovic

Abstract
The course covers fundamentals of computational optimization methods in the context of engineering design. It develops skills to formally state and model engineering design tasks as optimization problems and select appropriate methods to solve them.

Objective
The lecture and exercises teach the fundamentals of optimization methods in the context of engineering design. After taking the course students will be able to express engineering design problems as formal optimization problems. Students will also be able to select and apply a suitable optimization method given the nature of the optimization model. They will understand the links between simulation, optimization and engineering design in order to design more efficient and performance optimized technical products. The exercises are MATLAB based.

Content

Lecture notes
available on Moodle

151-3207-00L Lightweight W 4 credits 4G P. Ermanni

Abstract
The lecture embraces lightweight materials, construction techniques, design principles and calculation methods for the analysis of the load bearing and failure behavior of lightweight structures.

Objective
The course aims to impart basic principles for the understanding and for the design and dimensioning of modern lightweight constructions in mechanical, automotive and aerospace engineering.

Content
Light metals and fiber reinforced plastics, technologies and construction techniques, frames and truss structures, bending, shear and torsion of open and closed, thin-walled constructions, statically undetermined systems, stability of thin-walled systems.

Lecture notes
Handouts

151-0735-00L Dynamic Behavior of Materials and Structures W 4 credits 2V+2U D. Mohr

Abstract
Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

Objective
Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material structures for high performance structures in automotive, aerospace and naval engineering. Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Content
Slides of the lectures, relevant journal papers and users manuals will be provided.

Literature
Various books will be recommended covering the topics discussed in class

Prerequisites / notice
Course in continuum mechanics (mandatory), finite element method (recommended)

151-0509-00L Microscale Acoutofluidics W 4 credits 3G J. Dual

Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication ) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective
Understanding acoustophoresis, the design of devices and potential applications

Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobotics to surface acoustic wave devices

Lecture notes
Engineering Tools IV

The participation at the Engineering Tools course is mandatory. If you miss any classes, no credit points will be awarded. For exemptions you have to contact the lecturer of the course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0015-10L</td>
<td>Engineering Tool IV/V: Experimental Modal Analysis</td>
<td>W</td>
<td>0.4 credits</td>
<td>1K</td>
<td>F. Kuster, K. Wegener</td>
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<td></td>
<td>All Engineering Tool courses are for MAVT-Bachelor students only.</td>
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<td></td>
<td>Number of participants limited to 16.</td>
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<td>Only one course can be chosen per semester.</td>
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<tr>
<td>Abstract</td>
<td>Measuring- and analysis-methods for the determination of transfer functions of mechanical structures. Evaluation and preparation of the measured data for visualisation and interpretation of the dynamic behaviour.</td>
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<tr>
<td>Objective</td>
<td>Introduction into the practical application of measuring- and analysis-methods for determination of transfer functions of mechanical structures. Evaluation and preparation of the measured data for visualisation and interpretation of the dynamic behaviour.</td>
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<tr>
<td>Content</td>
<td>Acquaintance with the acceleration- and force-sensors, measurement of transfer functions of mechanical structures, determination and description of modes of vibration by means of practical examples, introduction into the vibration theory and its fundamental terms, discrete oscillator.</td>
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<tr>
<td>Lecture notes</td>
<td>yes, distribution in the course (CHF 20.-)</td>
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<tr>
<td>Literature</td>
<td>David Ewins, Modal Testing: Theory and Practice</td>
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<tr>
<td>Prerequisites/notice</td>
<td>In the practical part of the course the participants self will make measurements on structures and then analyse them for eigenfrequencies and modes of vibrations.</td>
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<td>151-0017-10L</td>
<td>Engineering Tool IV/V: Introduction to Structural Testing</td>
<td>W</td>
<td>0.4 credits</td>
<td>1K</td>
<td>P. Ermanni, T. Heinrich</td>
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<td></td>
<td>Eligible to students of Focus Specialization &quot;Structure Mechanics&quot;.</td>
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<td>Number of participants limited to 18.</td>
<td>Only one course can be chosen per semester.</td>
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<tr>
<td>Abstract</td>
<td>Structural testing is a very broad and interdisciplinary field. Taking into account the limited time, the scope of this tool-course is to provide a general introduction to structural testing, with particular attention to theoretical and practical aspects of strain gage measurements. Furthermore a real engineering case is presented and discussed in small groups.</td>
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<tr>
<td>Objective</td>
<td>Introduction to structural testing. Focus lies in measurements with strain gages. Selected case-studies help the participant to better understanding critical issues and possible solutions.</td>
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<td>Content</td>
<td>Working with strain gages preparation of the structure, positioning and application of the strain gages, data-gathering, verification. Introduction to Structural Testing (Theory)</td>
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<tr>
<td>Lecture notes</td>
<td>Case Study: Problem presentation, development of possible solutions, presentation and discussion, testing in the lab.</td>
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<tr>
<td>Literature</td>
<td>Script is available (follow the link)</td>
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<tr>
<td>Prerequisites/notice</td>
<td>Number of participants is limited</td>
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<tr>
<td>151-0024-10L</td>
<td>Engineering Tool IV/V: Digital Automotive Plant Simulation Methods</td>
<td>W</td>
<td>0.4 credits</td>
<td>1K</td>
<td>P. Hora</td>
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<tr>
<td>Number of participants limited to 25.</td>
<td>Only one course can be chosen per semester.</td>
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<tr>
<td>Objective</td>
<td>Modern FEM tools for virtual modeling of forming processes. The course provides following concepts: - Fundamentals of non linear Finite-Element-Methods (FEM) - The development of the virtual model - Material properties - Tool and contact conditions - Process evolution - Introduction to AUTOFORM software - Independent simulation exercises</td>
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<tr>
<td>Content</td>
<td>The simulation tool AUTOFORM allows the design of metal working manufacturing processes, optimization and additionally the possibility to examine the expected process robustness of fabrication processes. The methods are exemplified and the application of the software is exercised in the scope of this course.</td>
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<tr>
<td>Lecture notes</td>
<td>Course documentation</td>
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<tr>
<td>Prerequisites/notice</td>
<td>maximal number of participants: 25</td>
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<tr>
<td>151-0025-10L</td>
<td>Engineering Tool IV/V: Introduction to CAM and Motion Simulation</td>
<td>W</td>
<td>0.4 credits</td>
<td>1K</td>
<td>M. Schmid, K. Wegener</td>
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<td>All Engineering Tool courses are for MAVT-Bachelor students only.</td>
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<tr>
<td>Number of participants limited to 40.</td>
<td>Only one course can be chosen per semester.</td>
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<tr>
<td>Abstract</td>
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<tr>
<td>Objective</td>
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<tr>
<td>Content</td>
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<td>Lecture notes</td>
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<td>Prerequisites/notice</td>
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</table>
Only one course can be chosen per semester.

Abstract
Introduction of integrated CAD applications CAM (Computer Aided Manufacturing), Motion Simulation (Kinematics)

Objective
The participants learn the possibilities of integrated CAD applications. The goal is to understand the procedures and the most important functions of these applications.

Content
CAM: Introduction to CAM, practical examples for a 3-axle milling machine
Motion simulation (kinematic): Introduction to the possibilities of the movement simulator. Practical examples.

Prerequisites / notice
Voraussetzungen
- CAD-Grundkenntnisse in NX (CAD 1. Sem.)
- Eigenes Laptop mit installierter, lauffähiger Software NX für die Durchführung der Übungen (Siemens NX kann über Stud-IDES kostenlos bestellt werden).

151-0027-10L Engineering Tool IV/V: Programming with LabView
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 16.

Abstract
An introduction is given to the LabView programming environment. The basic concepts of "virtual instruments" and data flow programming are presented. Computer-based exercises are solved during class. A simple electronic data acquisition module is used to demonstrate basic concepts of interface management and data acquisition.

Objective
Introduction to the LabView programming environment.
Understanding of fundamental concepts: virtual instruments, data flow programming, control structures, data types etc.
Development of basic programming skills using in-class exercises on computers.

151-0030-10L Engineering Tool IV/V: Modelling and Servo Axis Control of Machine Tool Manipulators
All Engineering Tool courses are for MAVT-Bachelor students only.

Prerequisites: Matlab skills; your laptop with Matlab/Simulink may be useful.

Number of participants limited to 30.

Abstract
This course covers model building and the applied stimulation of (power-assisted axles on production machinery using MATLAB/Simulink and provides a practical example of how drive parameters may be set up, how through simulation an optimal axis design can be developed and which characteristics of a production machine can be reliably estimated in advance.

Objective
The students are able to model servo axes considering all relevant components and process influences to simulate the achievable productivity.

Content
1. Introduction, complexity levels in model building for production machines.
2. Complexity level 1: Power-assisted axles, transmission systems, general structural model.
3. Complexity level 2: Robotic models, kinematics and dynamics
4. Complexity level 3: Multi-body models and finite element models
5. Regulation of power-assisted axles, cascade regulator and state regulator extensions.
7. Master slave and gantry operations with dispersed servo drive.
8. Simulation examples in MATLAB/Simulink ((Swivel axle, 5-axle milling machine, parallel kinematic milling machine, industrial robots).

Lecture notes
Wird abgegeben

Prerequisites / notice
Prerequisite is knowledge of Matlab.

151-0032-10L Engineering Tool IV: Introduction to the Methods of Six Sigma Quality Control and Lean Production
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 36.

Abstract
The course introduces to Six Sigma quality management and quality improvement, which aims to reduce process variation and to sustain process capability. It introduces also to the Lean production principles, aiming to reduce waste within the processes as well as aiming to a customer taked pull-production.

Objective
The participant gets an overview to the Operational Excellence philosophy and the working methods of these two approaches. He learns the most important tools and the interaction of these two approaches.
Content

1. Understanding the changing environment
   - Globalization, customer requirements, production systems
   - Six Sigma quality philosophy
   - Lean Manufacturing and TPS (Toyota Production System)

2. Quality management with Six Sigma
   - What is Six Sigma
   - DMAIC problem solving cycle
   - Use of different control charts
   - Evaluate process capability, DPMO, Cpk, Taguchi
   - Cause-effect diagram
   - Control plan and sustainability, PDCA

3. Introduction to the Lean approach
   - Lean goals and principles
   - A3 project management
   - The 9 types of waste
   - Value add and non value add activities
   - The 8 Lean-Tools, whereof 4
   - 5S workplace organization
   - Value stream mapping (excercise), Little's law
   - Continuous flow vs batch
   - Pull Principles, Kanban, DBR
   - Cell design
   - Linear Programming

4. Lean and Six Sigma in practice
   - How fits Lean and Six Sigma together
   - Continuous Improvement/Kaizen organization
   - Change-Management, risks
   - Inspire deployment approach

Lecture notes

Notes will be distributet.

151-0044-10L  Engineering Tool IV/V: Computational Fluid Dynamics (CFD) with OpenFoam
   W  0.4 credits  1K  P. Jenny

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 40.

Abstract

Participants will learn to use the open source simulation software OpenFOAM on a user level (i.e. to conduct classical CFD studies). We will also introduce the students into programming with OpenFOAM so they will be able to implement additional equations into existing solvers.

Objective

Participants will learn to use the open source simulation software OpenFOAM on a user level (i.e. to conduct classical CFD studies). We will also introduce the students into programming with OpenFOAM so they will be able to implement additional equations into existing solvers.

Content

OpenFOAM is a very professional open-source simulation package which is freely (CHF 0.-) available under the GNU General Public License (GPL). It consists of a vast C++ library, many different applications and additional tools. Although most of the existing applications are flow solvers, OpenFOAM can be used in many different areas, as varied as solid dynamics, electromagnetics or pricing of financial options.

Most users make only use of the included applications. One particular strength of OpenFOAM, however, is that new applications and even extensions of the library can be developed in a rather compact and elegant way.

Literature


Prerequisites / notice

Knowing C++ or at least having some experience in another programming language will be of an advantage but is not strictly required to follow this course.

151-0057-10L  Engineering Tool IV/V: Systems Engineering for Project Work
   W  0.4 credits  1K  R. Züst, K. Wegener

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 60.

Abstract

The course is about a methodical basis of systematic project work, with a focus on demanding interdisciplinary problems. The participants will be shown how to use it appropriately and correctly in their projects. This short course is based on the "Systems Engineering" (SE) method, which was developed at the ETH.

Objective

The goals of this compact course are:
   - Goal-oriented identification and perception of relevant problem areas and project goal setting.
   - Deduction and development of procedures for a promising project, including systematic planning of the project content.
   - Development of work packages including efficient methodology
   - Simple embedding of the projects in the organization, including relationships with buyers, users and securing project participation.
1. Nachmittag:
- Einstieg ins Systems Engineering; Entstehung, Inhalt und Werdegang; Voraussetzungen (anspruchsvolle Fragestellungen, institutionelle Einbettung, Systemdenken und heuristische Prinzipien);
- Grundstruktur und Inhalt Lebensphasenmodell; Grundstruktur in Inhalt Problemlösungszyklus;
- Zusammenspiel von Lebensphasenmodell & Problemlösungszyklus in Projekten

2. Nachmittag:
- Situationsanalyse: Systemanalyse (Systemabgrenzung (gestaltbarer Bereich, relevante Bereiche des Umsystems)), Methoden der Analyse und Modellierung, Umgang mit Vernetzung, Dynamik und Unsicherheit; wichtigste Methoden der IST-Zustands- und Zukunftsanalyse);
- Zielformulierung (wichtigste Methoden der Zielformulieren);
- Konzeptsynthese und Konzeptanalyse (u.a. Kreativität; wichtigste Methoden der Synthese und Analyse),

3. Nachmittag:
- Beurteilung (u.a. Methoden für mehrdimensionale Kriterienvergleich, z.B. Kosten-Wirksamkeits-Analyse); Diskussion von Planungsbeispielen
- Diskussion von Planungsbeispielen: Analyse des Methodeneinsatzes, Entwickeln alternativer Vorgehensschritte und Auswahl des zweckmäßigssten Vorgehens

Lecture notes
Zusammenfassung wird in elektronischer Form abgegeben;
Lehrbuch: die Grundlagen sind in einem Lehrbuch beschrieben
Anwendungsbeispiele: 8 konkrete Anwendungen von Systems Engineering sind in einem Case-Book beschrieben

Prerequisites / notice
Zielpublikum: Der Kurs richtet sich insbesondere an Personen, welche anspruchsvolle Projekte initiieren, planen und leiten müssen
Lernmethode: Der Stoff wird mittels kurzer Vorträge vermittelt und an kurzen Fallbeispielen/Übungen vertieft. Zudem sollen die Lehrinhalte durch selbständiges Studium der Lehrmittel vertieft bzw. ergänzt werden.

151-0059-10L Engineering Tool IV: CAD-Methodology and PDM-Technology in the Focus Project
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 25.

Abstract
The participants learn about the procedures and tools that are necessary to develop technical products. The focus is on computer-based design and development and the management in an integrated software environment.

Objective
The participants will deepen their existing CAD knowledge and learn new PDM knowledge, so that these may be directly applied and used in the focus project.
- CAD refresh (Modelling, Assembling, Drafting, etc.) and CAD mythology for construction (Top-Down modelling)
- Introduction to the Team Center (Siemens PDM System)
- TeamCenter data flow, in particular the process of creating and managing new Items and Parts, the approval procedure and creating different versions of Parts

The participants will learn and experiment with procedures by working on concrete examples so that they will subsequently be able to begin with independent product construction.

The following topics will be dealt with in depth in the lectures supporting the focus project (Praxiskurs): CAD-Methodology, FE calculations, motion simulation and construction methodology.

Content
1. Afternoon: CAD refresher and top down modelling
   - To refresh already existing knowledge of CAD functionality,
   i. Sketch and features as well as manipulation and optimizing models.
   ii. Assembling
   iii. Drafting.
   iv. Organisation. working methods, conventions.

   - Top down modelling CAD
   i. Introduction to top down modelling and concept modelling
   ii. Case study of top down modelling

2. Afternoon: Introduction to TC (Team Center)
   - Introduction: Short introduction to PLM (What is the idea of PLM? PLM is more than the pure management of drawings!).
   - Lesson 1 - Team Center Rich Client Interface
   - Lesson 2 - TC data types
   - Lesson 3 - Construction from data in TC
   - Lesson 4 - Searching for and examining data.
   - Lesson 5 - Unit lists (PSE)
   - Lesson 6 - Cross-referencing
   - Lesson 7 - Data release
   - Lesson 8 - Product data examination

3. Afternoon: TC application
   - at least two students of a Focus-Team should sign in for this course, if teh use of Siemens TeamCenter PLM is given for the Team.
   - only for students participating in a Focus Project in the same semester
   - not more than 25 students

151-0061-10L Engineering Tool IV/V: Scientific Writing with LaTeX and Vector Graphics
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 40.

Abstract
This course provides insights into the structure and compilation of scientific papers and publications using LaTeX as well as open source software for image editing and the creation of vector graphics. LaTeX is a typesetting tool that separates text format and layout. It is widely used for reports and publications in the scientific domain.

Objective
By looking at specific examples during class you will obtain an overview on composing scientific papers (e.g. bachelor theses, seminar theses, master theses) using LaTeX and acquire the most important commands to typeset complex formulas, tables and graphics.
Content
-- layout of scientific reports
-- writing with LaTeX (structure, formatting, formulas, tables, graphics, references, table of contents, hyperlinks, packages) based on a template for bachelor/semester/master theses.
-- graphic design and illustration using open source software and Matlab
-- including PDF files in the report (project description, data sheets)
-- managing bibliography databases

Literature
http://www.relab.ethz.ch/education/courses/engineering-tools-latex.html

Prerequisites / notice
Particular:
The exercises will be done on your personal laptop (at least one laptop per two students). The entire LaTeX package, Inkscape and Gimp should be installed in advance.

151-0067-10L  Engineering Tool IV: Sketching and Visualization of Technical Concepts
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 20.

Abstract
This course is offered by the Design and Technology Lab Zurich. Effective visualizations of ideas are essential to communicate technical concepts. This course focuses on the basics of a coherent draft design through forms of sketches using various simple techniques.

Objective
Mastering various simple techniques for the visualization of technical ideas.

Content
Basics in: Perspective, line drawing, proportions, implementation of the plan views of perspective will be distributed

Literature
It requires no further books

Prerequisites / notice
Max 20 participants

151-0069-10L  Engineering Tool IV: Design Optimization and CAD
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 20.

Abstract
Participants will learn about the Computer-Aided Engineering fundamentals and methods that are necessary for successful design of modern technical products. The focus will be placed on the simulation-driven design in the context of product development process as well as on the fundamentals of the design optimization.

Objective
Basic Computer-Aided Engineering (CAE) knowledge and skills will be acquired to enable students to recognize both the advantages and the limitations of current CAE tools. Examples of how to build feature-based and parametric models for simulation-driven design automation will be given along with common pitfalls. The CAE environment will be the Siemens NX 8.5 which couples the simulation modeling (e.g. structural, thermal, flow, motion, and multiphysics) with design optimization and Feature-Based Design (FBD). After taking the course students should be able to independently create effective feature-based and parametric models to suit the requirements of simulation-driven design.

Content
1. Computer-Aided Engineering (CAE) methods and tools in context of design process (2 afternoons):
* CAE in the context of the design process
* Simulation-driven design
* Introduction to design optimization
* Features, parameterization and synchronous modeling technology
* Basic design optimization examples
* Introduction to Finite-Element Method (FEM) with basic examples

2. Simulation-Driven Design with application to structural design (1 afternoon):
* Coupling simulation with structural design optimization and feature-based design
* Simulation driven design examples (single parts and assemblies)

Lecture notes
Handouts in the lecture

Literature
1. CAD NX:
2. CAE NX:

Prerequisites / notice
Max. 25 participants

151-0091-10L  Engineering Tool IV: Scientific Writing
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 50.

Abstract
Participants acquire scientific writing basics as a core competency to communicate with different audiences. They apply important methods and tools to refine a scientific question, research and evaluate the necessary information, quote and paraphrase, and to plan the structure of their own text.

Objective
Students are able to
- derive and structure ideas for a text starting from a scientific question using simple techniques
- find literature sources, check their relevance and completeness, organize them with a suitable tool and cite correctly
- apply a reading technique for summarizing a text
- distinguish plagiarism, quotation and paraphrase in texts using the presented criteria and correctly cite or paraphrase external content
- use and cite information from the Internet correctly
- plan and structure specialized texts that refer to different target groups
KURSPROGRAMM
1. Halbtag: Recherchieren und Lesen
(1) Auf Vorhandenem aufbauen
(2) Ideen generieren
(3) Recherchieren
(4) Quellen beurteilen
2. Halbtag: Paraphrasieren nicht Plagiarisieren (1 Nachmittag, 3 Stunden, 15 min Pause)
(1) Verantwortlich sein: der Wert des eigenständigen Denkens
(2) Regeln und Anweisungen: was ist ein Plagiat, wie wird es an der ETHZ gehandhabt, Eigenständigkeitserklärung, Prüfwerkzeuge
(3) Zitieren und Paraphrasieren - so geht’s
(4) Paraphrasieren oder Zitieren?
(5) Lesen und verstehen
(6) Vom Umgang mit Quellen und Material aus dem Internet
3. Halbtag: Einen Text strukturieren und generieren
(1) Verwendung einer Standard-Textstruktur als Vorlage für ein Outline
(2) Ein Grundgerüst mit Abschnitten erstellen
(3) Eine Textabschnitt schreiben

LEHRFORMEN
- Inputs: Kurzvorträge
- Uebungen: während des Nachmittags selbständig in Moodle anhand von Fallstudien
- Feedback und Diskussion: Lösungen der Studierenden via Moodle an Dozentenbeamer und Besprechen durch die Dozierenden

Zu allen Inhaltsteilen gibt es Übungsteile in Moodle, für die ein Laptop mit funktionierendem Internetanschluss benötigt wird.


Prerequisites / notice
- Computer für Online-Übungen während der Veranstaltung.

151-0062-10L Engineering Tool V: Computer-Aided Design Methods W 0.4 credits 1K T. Stankovic, K. Shea
Number of participants limited to 25. All Engineering Tool courses are for MAVT-Bachelor students only.

Abstract
Participants will learn about the Computer-Aided Design fundamentals and methods that are necessary to model complex technical products. The focus will be placed on feature-based and parametric modelling that is common to all modern CAD tools used in mechanical engineering design.

Objective
CAD knowledge and skills will be further developed to enable students to recognize both the advantages and the limitations of current Computer-Aided Design tools. Examples of how to build feature-based and parametric models including design automation will be given along with common pitfalls. After taking the course students should be able to independently create effective feature-based and parametric models of mechanical parts.

Content
1. CAD Methods and Feature-Based Design (2 afternoons):
* CAD in the context of the design process
* Feature types and their relation to mechanical design
* Strategies for building feature-based assemblies
* Integration of digital part libraries
* Common issues and difficulties with feature interaction

2. CAD and Parametric Modeling (1 afternoon):
* Designing and building parametric models
* Design automation to create design variants
* Common issues and difficulties with parametric modelling

Workshop Training
Number Title Type ECTS Hours Lecturers
151-0003-00L Workshop Training O 5 credits external organisers
Abstract
Students are required to conduct a workshop training outside ETH Zurich for a minimum duration of five weeks. The students learn how to operate workshop equipment, and acquire first experience in the realization of an engineering project. They summarize the workshop practice in a work and project description.

Objective
The students learn how to operate workshop equipment, and acquire first experience in the realization of an engineering project.

Prerequisites / notice
The minimum duration of the workshop practice is five weeks. The practice may be done prior to the start of the study.

Laboratory Practice

Students attend at least 10 Laboratory Practices during the 4th and 5th semester. 4 of these must be Physics laboratories. All laboratory work is graded "pass" or "fail". After completion of 10 laboratory training units, 2 credit points will be issued.

Please register online at https://www.mavt.ethz.ch/praktika/index.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MAVT:

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
## Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<td>Bachelor's Thesis</td>
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<td>32D</td>
<td>Professors</td>
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<td>in cooperation with the industry are also possible.</td>
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<td>Prerequisites / notice</td>
<td>Supervisors should normally be part of the D-MAVT professorship or may be professors accredited by D-MAVT. The bachelor's thesis must be completed within 14 weeks, which is an equivalent half-time workload during a semester.</td>
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<th>Lecturers</th>
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<td>151-0071-10L</td>
<td>Bachelor's Thesis (Focus Spezialization Management, W</td>
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<td>32D</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Exclusively D-MAVT students who have enrolled for the focus specialization Management, Technology and Economy are eligible for this type of bachelor's thesis. Supervisors are normally part of the D-MTEC professorship. Further prerequisites have to be discussed with the responsible professor. The bachelor's thesis must be completed within 14 weeks which is an equivalent half-time workload during a semester.</td>
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### Mechanical Engineering Bachelor - Key for Type

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

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<td>exercise</td>
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<td>diploma thesis</td>
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<td>S</td>
<td>seminar</td>
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<td>revision course / private study</td>
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<td>colloquium</td>
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### ECTS

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
**Mechanical Engineering Master**

► **Core Courses**

►► **Energy, Flows and Processes**

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>151-0203-00L</td>
<td>Turbomachinery Design</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>R. S. Abhari, N. Chokani, B. Ribi</td>
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<tr>
<td>Abstract</td>
<td>Introduction to the understanding of a broad range of turbomachinery devices. Learn the steps of turbomachinery design.</td>
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<td>Objective</td>
<td>Understand the principles, and learn the design procedures and the behaviour of turbomachines.</td>
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<td>Lecture notes</td>
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</table>

| 151-0851-00L | Robot Dynamics | W    | 4 credits | 2V+1U | R. Siegwart, M. Hutter, K. Rudin, T. Stasny |
| Abstract | We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing. |
| Objective | The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems. |
| Content | The course consists of three parts: First, we will refresh and deepen the student’s knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different types of helicopters, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics. |
| Prerequisites / notice | The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics. |

| 151-0251-00L | IC-Engines and Propulsion Systems I | W    | 4 credits | 2V+1U | K. Boulouchos, G. Georges, P. Kyrtatos |
| Abstract | Introduction to basic concepts, operating maps and work processes of internal combustion engines. Thermodynamic analysis and design, scavenging methods, heat transfer mechanisms, turbulent flow field in combustion chambers, turbocharging. Energy systemic role of IC engines: conventional and electrified vehicle propulsion systems and decentralized power generation. |
| Objective | The students learn the basic concepts of an internal combustion engine by means of the topics mentioned in the abstract. This knowledge is applied in several calculation exercises and two lab exercises at the engine test bench. The students get an insight in alternative power train systems. |
| Lecture notes | Lecture notes |

| 151-0207-00L | Theory and Modeling of Reactive Flows | W    | 4 credits | 3G   | C. E. Frouzakis, I. Mantzaras |
| Abstract | The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling. |
| Objective | Theory of combustion with numerical applications |
| Content | The analysis of realistic reactive flow systems necessitates the use of detailed computer models that can be constructed starting from first principles i.e. thermodynamics, fluid mechanics, chemical kinetics, and heat and mass transport. In this course, the focus will be on combustion theory and modeling. The reacting flow governing equations and the combustion chemistry are firstly reviewed, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Heterogeneous (catalytic) combustion, an area of increased importance in the last years, will be dealt in detail along with its coupling with homogeneous combustion. Finally, approaches for the modeling of turbulent combustion will be presented. Available numerical codes will be used to compute the above described phenomena. Familiarity with numerical methods for the solution of partial differential equations is expected. |
| Lecture notes | Handouts |

| 151-0185-00L | Radiation Heat Transfer | W    | 4 credits | 2V+1U | A. Steinfeld, A. Z'Graggen |
| Abstract | Advanced course in radiation heat transfer |
| Objective | Fundamentals of radiative heat transfer for high-temperature applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing. |
| Lecture notes | Copy of the slides presented. |

| 151-0105-00L | Quantitative Flow Visualization | W    | 4 credits | 2V+1U | T. Rösgen |
| Number   | Title                                | Type | ECTS  | Hours | Lecturers                    |

The goal of the lecture is to expound design characteristics of systems for process engineering applications. The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern process design and safety deals with the fundamentals of process apparatus, plant design and safety.

Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

Prerequisites / notice
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

Prerequisites / notice
The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.
New Enterprises for Engineers
Transforming Needs to Business Enterprises

Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Fick's laws; application and significance of mass transfer; comparison of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogeneous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Extensive class interactions capped with presentation by each (group) student of new enterprise plan

Three tests are offered for practicing the course material. Participation is voluntary.

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The class is practical in nature but emphasizes the basic understanding of the parameters that significantly contribute to the success of a new enterprise. It will be highly interactive with special selected guests from Selected guests from; companies founder, venture capital and business angel, and large corporation executive. Class attendance and active participation is required.

This course is primarily for engineering and natural science students at all levels who are interested in participating in the initiation or growth of a new enterprise. The new enterprise could be stand-alone start up or a new business unit for an existing enterprise.

A. Wokaun, A. Steinfeld

W 4 credits
3G

R. Büchel

Z 0 credits
0.5K

K. Heuntschi

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Fick's laws; application and significance of mass transfer; comparison of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogeneous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

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W 4 credits
3G

R. Büchel, S. E. Pratsinis

S. E. Pratsinis

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Fick's laws; application and significance of mass transfer; comparison of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogeneous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Extensive class interactions capped with presentation by each (group) student of new enterprise plan

Three tests are offered for practicing the course material. Participation is voluntary.
Objective
By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.

Content
- Probability theory, single and multiple random variables, mappings of random variables
- Stochastic differential equations, Ito calculus, PDF evolution equations
- Polynomial chaos and other expansion methods
All topics are illustrated with application examples from engineering.

Lecture notes
Detailed lecture notes will be provided.

Literature
Some textbooks related to the material covered in the course:

151-0911-00L Introduction to Plasmonics W 4 credits 2V+1U D. J. Norris

Abstract
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

Objective
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

Content
- Fundamentals of Plasmonics
  - Basic electromagnetic theory
  - Optical properties of metals
  - Surface plasmon polaritons on surfaces
  - Surface plasmon polariton propagation
  - Localized surface plasmons
- Applications of Plasmonics
  - Waveguides
  - Extraordinary optical transmission
  - Enhanced spectroscopy
  - Sensing
  - Metamaterials

Lecture notes
Class notes and handouts

Literature

Prerequisites / notice
Physics I, Physics II

151-0213-00L Fluid Dynamics with the Lattice Boltzmann Method W 4 credits 3G I. Karlin

Abstract
The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.

Objective
Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.
Content
The course builds upon three parts:
I Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.
II Theoretical basis of statistical mechanics and kinetic equations.
III Lattice Boltzmann method for real-world applications.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   - Particle's distribution function, Liouville equation, entropy, ensembles;
   - Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions; Vlasov equation;
   - Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   - Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   - Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   - Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.

5. Microflow:
   - Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   - Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   - Relativistic fluid dynamics; flows with phase transitions.

Lecture notes
Lecture notes on the theoretical parts of the course will be made available.
Selected original and review papers are provided for some of the lectures on advanced topics.
Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

Prerequisites / notice
The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

151-0107-20L High Performance Computing for Science and Engineering (HPCSE) I

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

151-0182-00L Fundamentals of CFD Methods

Abstract
This course is focused on providing students with the knowledge and understanding required to develop simple computational fluid dynamics (CFD) codes to solve the incompressible Navier-Stokes equations and to critically assess the results produced by CFD codes. As part of the course, students will write their own codes and verify and validate them systematically.

Objective
1. Students know and understand basic numerical methods used in CFD in terms of accuracy and stability.
2. Students have a basic understanding of a typical simple CFD code.
3. Students understand how to assess the numerical and physical accuracy of CFD results.

Content
1. Governing and model equations. Brief review of equations and properties
2. Overview of basic concepts: Overview of discretization process and its consequences
3. Overview of numerical methods: Finite-difference and finite-volume methods
4. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
5. Time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
6. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
7. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov's theorem, TVD methods, DRP methods
8. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
9. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
10. Solution of one-dimensional advection-diffusion equation: Numerical vs physical viscosity, boundary layers, non-uniform grids
11. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, fractional-step and pressure-correction methods
12. Solution of incompressible Navier-Stokes equations on unstructured grids

Lecture notes
The course is based mostly on notes developed by the instructor.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0216-00L</td>
<td>Wind Energy</td>
<td>4 credits</td>
<td>Focuses on the fundamentals, technologies, modern day application, and economics of wind energy. The course will give an introduction to computational fluid dynamics and the basics of wind energy generation and conversion.</td>
</tr>
<tr>
<td>151-0368-00L</td>
<td>Aeroelasticity</td>
<td>4 credits</td>
<td>Introduces the basics and methods of Aeroelasticity. An overview of the main static and dynamic phenomena arising from the interaction between structural and aerodynamic loads.</td>
</tr>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>4 credits</td>
<td>Focuses on the fundamentals, technologies, modern day application, and economics of wind energy. The course will give an introduction to computational fluid dynamics and the basics of wind energy generation and conversion.</td>
</tr>
<tr>
<td>151-0215-00L</td>
<td>Introduction to Acoustics, Aeroacoustics and Thermoacoustics</td>
<td>4 credits</td>
<td>Focuses on the fundamentals, technologies, modern day application, and economics of wind energy. The course will give an introduction to computational fluid dynamics and the basics of wind energy generation and conversion.</td>
</tr>
<tr>
<td>101-0187-00L</td>
<td>Structural Reliability and Risk Analysis</td>
<td>3 credits</td>
<td>Focuses on the fundamentals, technologies, modern day application, and economics of wind energy. The course will give an introduction to computational fluid dynamics and the basics of wind energy generation and conversion.</td>
</tr>
</tbody>
</table>
Content

Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However, the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented. Bayesian networks are introduced as a generic numerical tool for solving such problems. The course also includes a tutorial using a software dedicated to real world structural reliability analysis.

Literature


Prerequisites / notice

Basic course on probability theory and statistics

Mechanics, Materials, Structures

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0317-00L</td>
<td>Visualization, Simulation and Interaction - Virtual Reality II</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Kunz</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.</td>
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<tr>
<td>Objective</td>
<td>Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.</td>
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<tr>
<td>Content</td>
<td>Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality</td>
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<tr>
<td>Lecture notes</td>
<td>The handout is available in German and English.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: “Visualization, Simulation and Interaction - Virtual Reality I” is recommended. Didactical concept: The course consists of lectures and exercises.</td>
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</table>

| 151-0349-00L   | Fatigue Strength of Materials, Components and Structures | W    | 4    | 3G    | M. Guillaume, R. E. Koller |
| Abstract       | Fatigue of materials is playing a key role in light weight structures. All applications are affected that are exposed to oscillating loads. The lecture will present the most important methods for analyzing the fatigue strength under service load conditions. This starts with the conventional assessment of a components endurance limit and ends with the application of the damage tolerance philosophy. |
| Objective      | Goals of the lecture An introduction to the most important terms and phenomena related to fatigue damages of metallic components will be given and explained by practical examples. Methods for assessment of endurance strength, finite life fatigue strength, crack initiation and crack growth will be discussed. The lecture shall demonstrate how to solve fatigue problems in practice. Examples like the ICE disaster at Eschede or structural problems of the Combino tram demonstrate the significance of this subject. The fatigue behavior of lightweight structures for vehicles and aircrafts has to be considered during the component design process. Designing the static strength of a component alone is not sufficient since fatigue damages of such components may cause extremely high costs. Structural components of modern aircraft like Airbus A380 or A400M are designed with respect to crack growth using the damage tolerance philosophy. Understanding fatigue strength and its phenomena requires broad knowledge of material behavior, services loads, manufacturing effects as well as of analysis and test methods. Fatigue strength is a highly interdisciplinary area of work. For this the most important tools and methods shall be presented. |
1. INTRODUCTION, OVERVIEW, MOTIVATION
   1.1 Preface (General introduction and history survey) (Schijve; Chapter 1)
   1.2 Standards and Guidelines
   1.3 Examples of damage events
      - Comet-Accident (Pressure cycles, stress concentration)
      - Aloha-Incident at Hawaii (Multiple site damage)
      - Accident of an aerial passenger tramway (Fretting corrosion on axle)
      - ICE-Accident (Wheel failure)
   1.4 Presentations
      - DVD "MTW Materialermüdung (1995, 21')"
      - DVD "F/A-18 Full Scale Fatigue Test (2004, 12')"
      - DVD "Sicherheit von Seilbahnen (1996, 7')" with discussion

2. LOADING
   2.1 Fatigue strength overview
   2.2 Significance of operational loading
   2.3 Types of load histories (Schijve; Chapter 9)
   2.4 Terms and definitions (Schijve; Chapter 9)
   2.5 Measurement of operational loadings (Schijve; Chapter 9)
   2.6 Counting algorithms (Schijve; Chapter 9)
   2.7 Frequency distributions or spectra (Schijve; Chapter 9)
   2.8 Impact of spectrum shape
   2.9 Design Spectra (Schijve; Chapter 13)

3. MATERIAL
   3.1 Fatigue strength overview
   3.2 Evaluation of material properties for cyclic loading (Schijve; Chapter 13)
   3.3 Fatigue properties (Schijve; Chapter 6)
   3.4 Wöhler-Diagram (Schijve; Chapter 6, 7)
   3.5 Scatter of fatigue properties (Schijve; Chapter 12)
   3.6 Mean stress effect (Schijve; Chapter 6)
   3.7 Damage mechanisms & material selection (Schijve; Chapter 2)
   3.8 Environmental effects (Schijve; Chapter 16, 17)
   3.9 Specific fatigue properties (Schijve; Chapter 6)

4. STRUCTURAL COMPONENT
   4.1 Fatigue strength overview
   4.2 Notches (Schijve; Chapter 3, 7)
   4.3 Residual stresses (Schijve; Chapter 4)
   4.4 Size effect
   4.5 Surface condition and surface layers (Schijve; Chapter 7, 14)
   4.6 Fretting corrosion (Schijve; Chapter 15)
   4.7 Summary of fatigue strength improving methods (Schijve; Chapter 14)

5. SAFETY FACTORS (Schijve; Chapter 19)

6. FATIGUE STRENGTH ASSESSMENT
   6.1 Fatigue strength overview
   6.2 Assessment concepts for fatigue lifetime prediction
   6.3 Assessment of the endurance strength
   6.4 Finite life fatigue strength assessment using the nominal stress concept (Schijve; Chapter 10)
   6.5 Local stress-strain concept (Schijve; Chapter 10)
   6.6 Fracture mechanics concept (Schijve; Chapter 5, 8, 11)
   6.7 Accuracy of concepts for fatigue lifetime assessment

7. STRUCTURAL INTEGRITY CONCEPTS
   7.1 Safe life design (Mirage III, Pressure Vessel)
   7.2 Fail safe design (modern aircraft construction)
   7.3 Damage tolerance (approach according to US Air Force)
   7.4 F/A-18 design philosophy
   7.5 Summary

8. EXPERIMENTAL FATIGUE STRENGTH
   8.1 In case of interesting current tests laboratory visitation at Empa

Lecture notes
All lecture chapters are on PowerPoint presentations. The chapters will be available as presentation handouts at the first day for a fee of CHF 20.-

Literature
Recommended books as supplement to the lecture:

Schijve, Jaap
Fatigue of Structures and Materials

Broek, David
The Practical Use of Fracture Mechanics

Prerequisites / notice
Depending on actual fatigue tests a Laboratory visitation at Empa in Dübendorf may be organized.

151-0353-00L Mechanics of Composite Materials W 4 credits 2V+1U G. Kress

Abstract
The course Mechanics of Composite Materials is dedicated to modeling problems following from the complex mechanical behavior of these anisotropic material structures. and modeling of continuous fibre reinforced composites. Participants will be able to design parts for the mechanical, automotive and aerospace industry.

Objective
Understanding of the mechanical properties of fiber reinforced composites with regard to analysis and design of lightweight structures for mechanical, transportation and aerospace applications.
1. Introduction and Elastic Anisotropy
2. Laminate Theory
3. Thick-Walled Laminates and Interlaminar Stresses
4. Edge Effects at Multidirectional Laminates
5. Micromechanics
6. Failure Hypotheses and Damage Prediction
7. Fatigue Response
8. Joining and Bonding Techniques
9. Sandwich Designs

Lecture notes
Manuscript and handouts in printed form and as PDF-files:
http://www.structures.ethz.ch/education/master/intro/compulsory/mechanics

Literature
The lecture material is covered by the script and further literature is referenced in there.

151-0357-00L
Ropeway Technology
4 credits
W
3G
G. Kovacs

Abstract
Ropeways represent a public transport system where steel wired ropes play a central role. Such systems come to a favorite transport solution when the costs for conventional systems become out of scale due to difficult and impossible terrestrial surface (alpine terrain).

Objective
Additionally ropeways are environment friendly, very energy efficient and offer a very high safety level.

Content
Cable cars make use of extensive mechanical systems, which because of their operational location, are exposed to difficult meteorological and topographical conditions. In order to guarantee the requisite safety and reliability of the equipment, the components and their interaction in the system must fulfill stringent functional requirements. This is particularly the case because of the significant distance (2-4km) between the individual structures.

The lectures with related exercises offer an excellent opportunity to apply the learned theoretical basic principles of mechanics and engineering in plant construction. Not only the function and resistance of individual components will be studied, but also complex interactions, which are imperative for the safe and smooth running of the equipment. It also includes the teaching of the basics of project planning and design, as well as the evaluation of systems in a distinctly interdisciplinary manner. For the manufacturer of a cable car installation the integration of sub-assembly making use of very different technologies always poses a particular challenge. For this reason, the methodology for the handling of these typical engineering assignments is important and makes up a significant part of the lecture content.

151-0360-00L
Procedures for the Analysis of Structures
4 credits
W
2V+1U
G. Kress

Abstract
Basic theories for structure integrity calculations are presented with focus on strength, stability, fatigue and elasto-plastic structural analysis.

Objective
Theories and models for one dimensial and planar structures are presented based on energy theorems.

Content
1. Basic problem of continuum mechanics and energy principles: structural theories, homogenization theories; finite elements; fracture mechanics.
3. Strength of material theories and material properties: ductile behaviour, plasticity, von Mises, Tresca, principal stress criterion; brittle behaviour; viscoplastic behaviour, creep resistance.
4. Structural design: fatigue and dynamic structural analysis.

151-0524-00L
Continuum Mechanics 1
4 credits
W
2V+1U
E. Mazza

Abstract
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

Objective
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

Content

151-0525-00L
Wave Propagation in Solids
4 credits
W
2V+1U
C. Daraio

Abstract
The course will cover the basic principles of wave propagation in periodic media. It will discuss the fundamental principles used to describe linear and nonlinear wave propagation in continuum and discrete media. Selected recent scientific advancements in the dynamics of periodic media will also be discussed.

Objective
Students learn the basic principles governing the propagation of waves in discrete and continuum solid media. These methods can be used to engineer materials with predefined properties and to design dynamical systems for a variety of engineering applications (e.g., vibration mitigation, impact absorption and sound insulation).

Content
Wave propagation in solids including applications. Phenomenology of wave propagation (plane waves, harmonic waves, dispersion, attenuation, group and phase velocity), transmission and reflection, impact problems, waves in linear elastic media, discrete media, experimental and numerical methods.

1376-1219-00L
Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions
3 credits
W
2V
R. Riener, R. Gassert, L. Marchal Crespo

Abstract
Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 955 of 1432
Content

Introduction, problem definition, overview
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
- Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
- Rehabilitation and use of kinesthetic and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
- Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
- Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
  - Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
  - Brain-Computer Interfaces

Literature

Introductory Books:

Selected Journal Articles and Web Links:
- VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

Prerequisites / notice

Target Group:
- Students of higher semesters and PhD students of D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome

151-0535-00L Optical Methods in Experimental Mechanics W 4 credits 3G E. Hack, R. Brönnimann
The students are able to describe simple optical set-ups and image formation by using a camera system. They understand the working principle of various camera-based techniques for shape, deformation and strain measurement. Most notably they can explain how the measurand is transformed into an interference signal, a change of polarization or temperature, or a different signal modulation. They know the main application fields of the individual techniques. They are able to choose the most appropriate technique for solving a measurement task and to estimate its expected resolution. Through the hands-on experience the students gain a deeper and sustained understanding of the theoretical content by applying the theoretical foundations to dedicated measurement tasks.

In addition, dynamic measurements and vibration analysis are explained in the context of modal analysis or transient events. The calibration of imaging optical methods and their application to the validation of numerical simulations are described.

The lecture includes two afternoons of laboratory experience at Empa, where the student will take the first steps with optical methods. Hands-on experience includes e.g. Digital Image Correlation, Speckle pattern interferometry, Thermal Stress Analysis, Fibre optic sensors, Fringe projection, depending on availability of the equipment and the interest of the students.

- Application on the facilities projecting
- Controlling philosophies, emergency concepts, production in sequence, line production, rescheduling
- Procedure for application: optimizing, experimental design planning, analysis, data preparation
- Internal organisation and functionality of simulation tools
- Exemplary application of a software tool (Technomatrix-Simulation-Software)
- Infrared radiation (Thermal Stress Analysis)

The knowledge is enhanced by practice-oriented exercises and an excursion. A guest speaker will present a practical example.
Deepened discussion on the machining processes and their optimisation. Outlook for additional areas such as NC-Technique, dynamics of processes and machines, chatter as well as process monitoring.

**Content**
- Deepened insight in the machining processes and their optimisation, chip removal by undefined cutting edge, such as grinding, honing and lapping, machining processes without cutting edges, such as EDM, ECM, outlook in additional areas as NC-technique, machine- and process dynamics including cutting and process monitoring

**Prerequisites / notice**
- Prerequisites: Recommendation: Lecture 151-0700-00L Manufacturing elective course in the 4th semester.
- Language: Help for English speaking students on request as well as English translations of slides shown.

**151-0717-00L Forming Technology I - Basic Knowledge**

**Abstract**
The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is:
- deformation specific description of material properties and their experimental measurement,
- material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.

**Objective**
- Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.

**Content**
- Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plastic-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology. Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.

**Prerequisites / notice**
- Help for English speaking students on request.
- Parts of the lecture are held in English.

### Forming Technology III - Forming Processes

**W 151-0733-00L**

- **Abstract**: The lecture teaches on the basic knowledge of major processes in sheet metal, tube and bulk metal forming technologies. In particular it focuses on fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.


- **Content**: 
  - The study of metal working processes: sheet metal forming, folding die cutting, cold bulk metal forming, ro extrusion, plunging, open die forging, drop forging, milling; active elementary; principle elements to estimate stress and strain; fundamentals of process design; manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.

- **Lecture notes**: ja

## Principles of Nonlinear Finite-Element-Methods

**W 151-0833-00L**

- **Abstract**: Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

- **Objective**: The goal of the lecture is to provide the students with the fundamentals of the nonlinear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:
  - Crash
  - Collapse of structures
  - Materials in Biomechanics (soft materials)
  - General forming processes

- **Content**: 
  - Fundamentals of continuum mechanics to characterize large plastic deformations
  - Elasto-plastic material models
  - Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
  - FEM implementation of constitutive equations
  - Element formulations
  - Implicit and explicit FEM methods
  - FEM formulations of coupled thermo-mechanical problems
  - Modeling of tool contact and the influence of friction
  - Solvers and convergence
  - Modeling of crack propagation
  - Introduction of advanced FE-Methods

- **Literature**: Bathe, K. J., Finite-Element-Procedures, Prentice-Hall, 1996

- **Prerequisites / notice**: If we will have a large number of students, two dates for the exercises will be offered.

## Image Analysis and Computer Vision

**W 227-0447-00L**

- **Abstract**: Light and perception. Digital image formation. Image enhancement and feature extraction. Unitary transformations. Color and texture. Image segmentation and deformable shape matching. Motion extraction and tracking. 3D data extraction. Invariant features. Specific object recognition and object class recognition.

- **Objective**: Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

- **Content**: The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

- **Lecture notes**: ja

- **Prerequisites / notice**: Course material Script, computer demonstrations, exercises and problem solutions

## Machine Learning

**W 252-0535-00L**

- **Abstract**: Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

- **Objective**: Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and.

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can.

No lecture notes, but slides will be made available on the course webpage.

Lecture notes

Literature


Prerequisites / notice

Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.


Abstract

This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

Objective

At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.

Content

This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.


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Crack-flaws cannot be neglected in engineering analysis. Even microscopic crack flaws can grow over time, ultimately resulting in fractured components. Structures that may have been blindly deemed “safe” could fail disastrously, causing injuries to its users, or the loss of life. Fracture mechanics can be used to:

* Determine how large a crack can be in a structure before it leads to catastrophic failure
* Predict the rate at which a crack can approach a critical size due to fatigue loads or aggressive environmental conditions

The topics covered are:

* Introduction to Linear Elastic Fracture Mechanics (LEFM); crack tip stress, strain and displacement fields in linear elastic materials (Modes I, II and III); the stress-intensity factor, K; the fracture toughness KIC and their determination; fracture criterion
* Estimates of crack plastic zones in ductile materials
* The compliance method; experimental determination of compliance
* Introduction to fracture mechanics of nonlinear materials: the J-integral; the JIC fracture criterion; JIC testing
* Application of fracture mechanics concepts in the analysis of subcritical crack growth (fatigue, stress corrosion cracking, creep and their combinations)
* Lifetime determination and prediction; failure analysis.

A successful participant of the course is able to:

- see “script" Strategic and tactical concepts in logistics, operations, and supply chain management: Conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the MRP II / ERP concept; business processes and methods; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.

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

<table>
<thead>
<tr>
<th>Content</th>
<th>Logistics, Operations and Supply Chain Management I W</th>
<th>3 credits</th>
<th>2G</th>
<th>P. Schönsleben, E. Scherer Casanova</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.</td>
<td></td>
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<tr>
<td>Objective</td>
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</tr>
<tr>
<td>Literature</td>
<td>Sales at 17.9.15, from 12:45, before and during breaks of the first lecture.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>As for the lecture of the 3rd week (BEMAD, a much-liked Business Engineering and Management Ability Development game), this lecture (of Oct. 1) will follow a specific schedule in specific rooms. The schedule will be presented at Sept. 17 during the 1st lecture.</td>
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<tr>
<td>Literature</td>
<td>Due to the big number of students, about half of the students will play this game, instead of Oct. 1, at Friday afternoon, Oct. 2. Please be available. Thank you for your help in this matter.</td>
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<table>
<thead>
<tr>
<th>Content</th>
<th>Systems Dynamics and Complexity</th>
<th>W</th>
<th>3 credits</th>
<th>3G</th>
<th>F. Schweitzer, P. Mavrodiev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption A successful participant of the course is able to:</td>
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</tr>
<tr>
<td>Content</td>
<td>- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches - apply the problem solving cycle as a systematic approach to identify problems and their solutions - calculate project schedules according to the critical path method - setup and run systems dynamics models by means of the Vensim software - identify feedback cycles and reasons for unintended systems behavior - analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling. The course is structured along three main tasks:</td>
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<tr>
<td>Lecture notes</td>
<td>PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions. PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed. PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles. Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.</td>
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</table>
351-0555-00L  Open- and User Innovation  W  3 credits  2G  S. Häfliger, S. Spaeth

Abstract
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

Objective
The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Content
Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

Lecture notes
The slides of the lectures are made available and updated continuously through the SMI website:

Literature
Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

Reading assignments: please consult the SMI website:

363-0711-00L  Accounting for Managers  W  3 credits  2V  J.P. Chardonnens

Abstract
Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

Objective
Understand the different procedures involved in the accounting system
Record change in financial position
Measure business income
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Content
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,

Managerial Accounting: Full costing, variable costing, cost-volume-profit, break-even analysis, activity-based costing

Prerequisites / notice
This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture and basic combinatorial optimization problems.

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

Abstract
Introduction to basic techniques and problems of mathematical optimization.

Objective
The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

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

Literature
Information about relevant literature will be given in the lecture.

Prerequisites / notice
This course is a prerequisite for the course Financial Management.


Abstract
About 5 talks on applied statistics.

Objective
See how statistical methods are applied in practice.

Content
There will be about 5 talks on how statistical methods are applied in practice.

Prerequisites / notice
This is no lecture. There is no exam and no credit points will be awarded. The current program can be found on the web:
http://stat.ethz.ch/events/zukost
Course language is English or German and may depend on the speaker.


Abstract
Research colloquium

151-0917-00L  Mass Transfer  W  4 credits  2V+2U  R. Büchel, S. E. Pratsinis

Abstract
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.
Adaptive materials offer appealing ways to extend the design space of structures by introducing time-variable properties into them. In this context, Logistics, Operations, and Supply Chain Management by A. Guber, R.D. Moryson, W will provide an insight into the properties and physical phenomena which lead to the features of adaptive materials.

Cussler, E.L.: “Diffusion”, 2nd edition, Cambridge University Press, 1997. This course will provide the students with an insight into the properties and physical phenomena which lead to the features of adaptive materials. Knowledge about the value added process sequence for electronics manufacturing, planning of electric and electronic product as well as to plan and control value-added systems, both in an industry and a service industry environment.

The study of adaptive materials covers topics that range from chemistry to theoretical mechanics. Basic concepts: Power conjugated variables, dissipative effects, geometry- and materials-based energy conversion


Thermo-mechanical coupling: Shape memory alloys / polymers

Electromechanical coupling(1): DEA, EBL, electrorheological fluids

Shape control / morphing: Use, requirements, challenges

Morphing applications of variable stiffness structures: Lab work

Electromechanical coupling (2): Piezoelectric, electrostrictive effect

Vibration Reduction: Measurement, passive, semi-active (active) damping methods

Vibration reduction applications of piezoelectric materials: Lab work

Magneto-mechanical coupling: Magnetostrictive effect, mSMA, magnetorheological fluids, ferrofluids

Energy harvesting and sensing: Energy harvesting with EAP and piezoelectric materials, transducers as sensors: Piezo, resistive,...
Engineering (HPCSE) I

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers

Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

Skills for Creativity and Innovation W 4 credits 3G I. Goiler, C. Kobe, M. Meboldt

Abstract
This lecture aims to enhance the knowledge and competency of students regarding their innovation capability. An overview on prerequisites of and different skills for creativity and innovation in individual & team settings is given. The focus of this lecture is clearly on building competencies - not just acquiring knowledge.

Objective
- Basic knowledge about creativity and skills
- Knowledge about individual prerequisites for creativity
- Development of individual skills for creativity
- Knowledge about teams
- Development of team-oriented skills for creativity
- Knowledge and know-how about transfer to idea generation teams

Content
Basic knowledge about creativity and skills:
- Introduction into creativity & innovation: definitions and models

Knowledge about individual prerequisites for creativity:
- Personality, motivation, intelligence

Development of individual skills for creativity:
- Focus on creativity as problem analysis & solving
- Individual skills in theoretical models
- Individual competencies: exercises and reflection

Knowledge about teams:
- Definitions and models
- Roles in innovation processes

Development of team-oriented skills for creativity:
- Idea generation and development in teams
- Cooperation & communication in innovation teams

Knowledge and know-how about transfer to idea generation teams:
- Self-reflection & development planning
- Methods of knowledge transfer

Lecture notes
Slides, script and other documents will be distributed via moodle.ethz.ch
(only for students registered to this course)

Colloquium on Manufacturing Technology W 4 credits 3K K. Wegener, F. Kuster

Abstract
Future training on selected current topics of the manufacturing technology. Per afternoon a selected topic is presented in several lectures, by the majority by experts from the industry. The students prepare a summary of the lectures given and prepare themselves on the basis of these lectures and own information search.

Objective
Continuous further training to current topics of the manufacturing technique. Exchange of experience and knowledge with the industry and other universities.

Content
Selected actual topics on manufacturing methods and tools, machine tools, NC-control and drives, components and measuring methods and devices. Topics are changing every year.

Lecture notes
no Script

Prerequisites / notice
- Students must have participated and passed the courses Manufacturing, Production Machines I and Forming Technology III - Forming Processes.
- Further training with specialized lectures and large participation from the industry.

Language: Help for English speaking students on request.

Aeroelasticity W 4 credits 2V+1U F. Campanile

Abstract
Introduction to the basics and methods of Aeroelasticity. An overview of the main static and dynamic phenomena arising from the interaction between structural and aerodynamic loads.

Objective
The course will give you a physical basic overview of current-structure phenomena. Furthermore you will get to know the most important phenomena in the statistical and dynamical aeroelastic as well as an introduction to the methods for mathematical descriptions and for the wording of quantitative forecasts.

Autumn Semester 2015
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>ECTS</th>
<th>Prerequisites / Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Menozzi Jäckli, R. Boutellier, R. Huang, M. Siegrist</td>
</tr>
<tr>
<td>151-0511-00L</td>
<td>Mechanics of Nano- and Micro-Materials</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>C. Daraio</td>
</tr>
<tr>
<td>151-3203-00L</td>
<td>Grand Challenges in Engineering Design</td>
<td>W</td>
<td>1</td>
<td>3S</td>
<td>P. Ermanni, M. Meboldt, K. Shea</td>
</tr>
<tr>
<td>151-0785-00L</td>
<td>Leading and Coaching Focus Project Teams (Basic Course)</td>
<td>W</td>
<td>0</td>
<td>1.5G+0.5A</td>
<td>R. P. Haas, I. Goller</td>
</tr>
</tbody>
</table>

**Abstract**

- Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

- The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be provided in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

- The course provides an introduction to the mechanics of nano- and micro-materials, in the quasistatic and dynamic domains. It reviews scale effects in materials, surveys available characterization techniques and describes the effects of surfaces and microscale contacts. Recent applications of nano- and micro-materials in engineering systems will be discussed.

- Learn the fundamental mechanical properties of nano- and micro-system. Understand the effects of scales on the response of materials. Explore applications and devices exploiting the response of materials at small scales.

- The course is structured in three main blocks, each of them addressing a specific grand challenge in engineering design. Each block is composed of an introductory lecture and two to three invited talks, considering a good mix between speakers coming from academia and industry. Each talk is introduced and moderated by the students.

- The aim of the course is to introduce students to the engineering design research and practice in a multitude of Mechanical Engineering disciplines and convey knowledge from both academia and industry about state of the art methods, tools and processes.

- The students are exposed to a variety of topics in the field of Engineering Design. Topics are bundled in three main grand challenges and include an introductory lecture held by one of the responsible Professors and 2-3 invited talks of 45 min. each, addressing specific issues. The success of the course is largely dependent on active involvement of the students. Accordingly, a small group of students (1-3) is asked to introduce and moderate each external talk. The group will therefore gather adequate information about the speaker and topic, read and synthesize relevant documents and scientific papers, prepare questions to motivate the interaction with the audience and summarize, at the end of the lecture, the discussed points and outcome.

- Offered in English and German

**Objective**

- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

**Prerequisites / Literature**

- Relevant articles and reading materials will be provided. Various books will be recommended pertaining to the topics covered.
- Mechanics I, II, III
- www.structures.ethz.ch/education/master/intro/compulsory/aeroelasticity

**Notice**

- Slides and notes from the course will be provided.
Content: Content of both basic and advanced course (2 semester):
- Basic knowledge about role and mindset of a coach
- Introduction into coaching: definition & models
- Introduction into the coaching process
- Role of coaches between examinator and "friend"
- Knowledge and reflection about the problems in coaching a focus project
- Knowledge about team development
- Reflection about critical phases in the innovation process for an innovation team
- Know-how about reference model for analysis critical situations
- Development of personal coaching competencies, e.g. active listening, asking questions, giving feedback
- Competencies in theoretical models
- Coaching competencies: exercises and reflection
- Knowledge and know-how about coaching methods
- Knowledge about basic coaching methods for technical projects/innovations projects
- Know-how about usage of methods in the coaching process
- Facilitating decisions
- Using and applying coaches opinions and knowledge
- Reflection and exchange of experiences about personal coaching situations
- Self-reflection
- Exchange of experiences in the lecture group
- Good practice on organizational and management aspects
- How to do system and concurrent engineering
- Project planning and replanning
- Facilitating conflict situations
- Discussing sample cases from former teams and actual cases of participants.

Lecture notes: Slides, script and other documents will be distributed via electronically (access only for participants registered to this course).

Prerequisites / notice: Participants (Students, PhD Students, Postdocs) should be part of the coaching team of focus project teams.

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences
- W 4 credits
- 3G J. Beck, P. Koumoutsakos

Objective: The course "Leading and Coaching Focus Project Teams (Basic Course)" (HS) is examined together with "Leading and Coaching Focus Project Teams (Advanced Course)" (FS) in FS with 4 ECTS.

Abstract: Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Content: The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Lecture notes: The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature: 1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice: Fundamentals of Probability, Fundamentals of Computational Modeling

151-0536-00L Dynamics of Structure-Variant Systems
- W 4 credits
- 2V+1U C. Glocker

Abstract: Contents: inequality problems in dynamics, in particular friction and impact problems: discontinuities in velocity and acceleration, accumulation points, combinatorial problems, set-valued constitutive laws, unilateral contacts, spray clutches, friction, pre-stressed springs, impact equations and impact laws, linear complementarity, quadratic optimization.

Objective: The lecture provides the students an introduction to modern methods for inequality problems in dynamics. The contents of the lecture are fitted to frictional contact problems in mechanics, but can be transferred to a large class of inequality problems in technical sciences. The purpose of the lecture is to acquaint the students with a consistent generalization of classical mechanics towards systems with discontinuities, and to make them familiar with inequalities treated as set-valued constitutive laws.

Content: Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes: Es gibt kein Vorlesungsskript. Den Studenten wird empfohlen, eine eigene Mitschrift der Vorlesung anzufertigen. Ein Katalog mit Slides, script and other documents will be distributed via electronically.

Railway Vehicle Dynamics  
W  4 credits  2V+1U  O. Polach

Abstract
After an introduction into the railway vehicle design, the modelling of the contact between wheel and rail, the building of a simulation model and the fundamentals of the track guiding will be explained. The applications of simulations in the development of railway vehicles will be presented and illustrated on examples.

Objective
Development of the theoretical basics regarding the track guiding and the vehicle running dynamics. Understanding the background of multi-body dynamics simulation tools and their application in the development of railway vehicles.

Content
Introduction into railway vehicle technology: Vehicle concepts, bogies, suspension systems, brakes, drives.
Use of multi-body simulations in the railway vehicle industry. Simulation programmes.
Vehicle model: Model building, modelling of coil springs, rubber to metal springs, air springs and suspension components with friction.
Wheel/rail contact: Contact geometry, contact area, normal forces, tangential forces.
Track models. Modelling of track irregularities.
Linearization of the contact geometry wheelset-track.
Fundamentals of track guiding.
Eigenbehaviour, calculation of eigenvalues.
Linearised and nonlinear calculation of running stability: Methods and assessment criteria. Influence of vehicle design on the running stability.
Ride comfort assessment.
Testing and simulations for the acceptance of running characteristics of railway vehicles. Validation of simulation models for the application in context of vehicle acceptance.

Lecture notes
Script will be provided.

Prerequisites / notice
Fundamentals of mechanics and physics.

227-0523-00L  
Railway Systems I  
W  6 credits  4G  M. Meyer

Abstract
Basic characteristics of railway vehicles and their interfaces with the railway infrastructure:
- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signalling systems
- Traffic control and maintenance

Objective
- Overview of the technical characteristics of railway systems
- Know-how about the design and construction principles of rail vehicles
- Interrelationship between different fields of engineering sciences (mechanics, electro and information technology, transport systems)
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Motivation of young engineers to start a career in the railway industry or with railway operators

Content
EST I (Frühjahrsemester) - Begriffen, Grundlagen, Merkmale

1 Einführung:
1.1 Geschichte und Struktur des Bahnsystems
1.2 Fahrdynamik

2 Vollbahnfahrzeuge:
2.1 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion
2.2 Bremsen
2.3 Traktionsantriebssysteme
2.4 Hilfsbetriebe und Komfortanlagen
2.5 Steuerung und Regelung

3 Infrastruktur:
3.1 Fahrweg
3.2 Bahnstromversorgung
3.3 Sicherungsanlagen

4 Betrieb:
4.1 Interoperabilität, Normen und Zulassung
4.2 RAMS, LCO
4.3 Anwendungsbeispiele

Voraussichtlich ein oder zwei Gastreferate

Geplante Exkursionen:
Betriebszentrale SBB, Zürich Flughafen
Reparatur und Unterhalt, SBB Zürich Altstetten
Fahrzeugfertigung, Stadler Bussnang

Lecture notes
Abgabe der Unterlagen (gegen eine Schutzgebühr) zu Beginn des Semesters. Rechtzeitig eingeschriebene Teilnehmer können die Unterlagen auf Wunsch und gegen eine Zusatzgebühr auch in Farbe beziehen.

Prerequisites / notice
Dozent: Dr. Markus Meyer, Emkamatik GmbH

Voraussichtlich ein oder zwei Gastvorträge von anderen Referenten.

EST I (Herbstsemester) kann als in sich geschlossene einsemestrige Vorlesung besucht werden. EST II (Frühjahrsemester) dient der weiteren Vertiefung der Fahrzeugtechnik und der Integration in die Bahlinfrastruktur.

151-0523-00L  
Microscale Acoustofluidics  
W  4 credits  3G  J. Dual

Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective
Understanding acoustophoresis, the design of devices and potential applications

Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobotics to surface acoustic wave devices
Lecture notes
Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

151-0735-00L Dynamic Behavior of Materials and Structures W 4 credits 2V+2U D. Mohr
Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

Objective
Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

Content
Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Lecture notes
Slides of the lectures, relevant journal papers and users manuals will be provided.

Lecturers
Various books will be recommended covering the topics discussed in class

3G Virtual Reality in Medicine
Introduction to methods of control and optimization of dynamic systems. Application to real engines. Understand the structure and behavior of drive train systems and their quantitative descriptions.

R. Riener
M. Harders

Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of higher semesters and PhD students of
- D-HEST, D-MAVT, D-ITET, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome!

Literature

The course language is English.

Basic experience in Information Technology and Computer Science will be of advantage

More details will be announced in the lecture.

151-0563-01L Dynamic Programming and Optimal Control W 4 credits 3G R. D’Andrea
Introduction to Dynamic Programming and Optimal Control.

Objective
Covers the fundamental concepts of Dynamic Programming & Optimal Control.

Content
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

Literature

Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

151-0567-00L Engine Systems W 4 credits 3G C. Onder
Introduction to current and future engine systems and their control systems

Objective
Introduction to methods of control and optimization of dynamic systems. Application to real engines. Understand the structure and behavior of drive train systems and their quantitative descriptions.

Content
Physical description and mathematical models of components and subsystems (mixture formation, load control, supercharging, emissions, drive train components, etc.).

Case studies of model-based optimal design and control of engine systems with the goal of minimizing fuel consumption and emissions.

Lecture notes
Introduction to Modeling and Control of Internal Combustion Engine Systems
Guzzella Lino, Onder Christopher H.
ISBN: 978-3-642-10774-0

Combined homework and testbench exercise (air-to-fuel-ratio control or idle-speed control) in groups

151-0569-00L Vehicle Propulsion Systems W 4 credits 3G C. Onder, P. Elbert
Introduction to current and future propulsion systems and the electronic control of their longitudinal behavior

Objective
Introduction to methods of system optimization and controller design for vehicles. Understanding the structure and working principles of conventional and new propulsion systems. Quantitative descriptions of propulsion systems

Content
Understanding of physical phenomena and mathematical models of components and subsystems (manual, automatic and continuously variable transmissions, energy storage systems, electric drive trains, batteries, hybrid systems, fuel cells, road/wheel interaction, automatic braking systems, etc.).

Presentation of mathematical methods, CAE tools and case studies for the model-based design and control of propulsion systems with the goal of minimizing fuel consumption and emissions.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Hours</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0573-00L</td>
<td>System Modeling</td>
<td>W</td>
<td>4</td>
<td>2V+2U</td>
<td>G. Ducard, C. Onder</td>
</tr>
<tr>
<td>151-0593-00L</td>
<td>Embedded Control Systems</td>
<td>W</td>
<td>4</td>
<td>6G</td>
<td>J. S. Freudenberg, M. Schmid Daners</td>
</tr>
<tr>
<td>151-0601-00L</td>
<td>Theory of Robotics and Mechatronics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Korba, S. Stoeter, B. Nelson</td>
</tr>
<tr>
<td>376-1219-00L</td>
<td>Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Riener, R. Gassert, L. Marchal Crespo</td>
</tr>
</tbody>
</table>

**Abstract**

System Modeling:

Objective:

Content:
- Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data. Examples: mechatronic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Planning of experiments, estimation techniques for "gray-box" models (linear and nonlinear least-squares methods). The exercises are solved in teams. One larger case study is to be solved.

Lecture notes:
- The handouts in English will be sold in the first lecture.
- A list of references is included in the handouts.

Embedded Control Systems:
- This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

Objective:
- Familiarize students with main architectural principles and concepts of embedded control systems.

Content:
- An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

Lecture notes:
- Lecture notes, lab instructions, supplemental material

Prerequisites / notice:
- Prerequisite courses are Control Systems I and Informatics I.
- This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: schmid@idsc.mavt.ethz.ch).
- After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Theory of Robotics and Mechatronics:
- This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degrees of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Objective:
- Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Content:
- The course will be taught in English.

Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions:
- An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degrees of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

Abstract:
- Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective:
- Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.
Content

Introduction, problem definition, overview
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
- Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
- Rehabilitation and use of kinesthetic and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
- Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
- Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
  - Brain stimulation and recording
- Rehabilitation of visual function
- Rehabilitation of hearing function
- Rehabilitation and use of kinesthetic and tactile function
- Rehabilitation of vestibular function
- Rehabilitation of vegetative Functions

Literature

Introductory Books:

Selected Journal Articles and Web Links:
- VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

Prerequisites / notice

Target Group:
Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
Students of other departments, faculties, courses are also welcome

151-0851-00L Robot Dynamics W 4 credits 2V+1U R. Siegwart, M. Hutter, K. Rudin, T. Staastny
Abstract
We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

Objective
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

Content
The course consists of three parts: First, we will refresh and deepen the student’s knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

Prerequisites / notice
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
<th>Lecture Notes</th>
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</thead>
<tbody>
<tr>
<td>227-0225-00L</td>
<td>Linear System Theory</td>
<td>6</td>
<td>J. Lygeros, M. Kamgarpour</td>
</tr>
<tr>
<td>Abstract</td>
<td>The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.</td>
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<tr>
<td>Objective</td>
<td>By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.</td>
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</tr>
</tbody>
</table>
| Content | - Rings, fields and linear spaces, normed linear spaces and inner product spaces. 
- Ordinary differential equations, existence and uniqueness of solutions. 
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case. 
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case. 
- Stability and stabilization, observers, state and output feedback, separation principle. 
- Realization theory. |
| Prerequisites / notice | Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity. |

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
<th>Lecture Notes</th>
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</thead>
<tbody>
<tr>
<td>227-0920-00L</td>
<td>Seminar in Systems and Control</td>
<td>Z</td>
<td>F. Dörfler, R. D’Andrea, J. Lygeros, R. Smith</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current topics in Systems and Control presented mostly by external speakers from academia and industry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>see above</td>
<td></td>
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<tbody>
<tr>
<td>151-0604-00L</td>
<td>Microrobots</td>
<td>W</td>
<td>B. Nelson</td>
</tr>
<tr>
<td>Abstract</td>
<td>Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.</td>
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</tbody>
</table>
| Content | Main topics of the course include: 
- Scaling laws at micro/nano scales 
- Electrostatics 
- Electromagnetism 
- Low Reynolds number flows 
- Observation tools 
- Materials and fabrication methods 
- Applications of biomedical microrobots |
| Lecture notes | The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically. |
| Prerequisites / notice | The lecture will be taught in English. |

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<tr>
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</thead>
<tbody>
<tr>
<td>151-0917-00L</td>
<td>Mass Transfer</td>
<td>W</td>
<td>R. Büchel, S. E. Pratsinis</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Three tests are offered for practicing the course material. Participation is voluntary.</td>
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</tbody>
</table>

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</tr>
</thead>
<tbody>
<tr>
<td>Number of participants limited to 26.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.</td>
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</table>
Objective

The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neuropsychology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical-human robot interaction, laboratory sessions and lab visits.

Students will attend laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://edu.haptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, Automation, etc.) during rendering of different mechanical properties.

Lecture notes

Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Literature


Prerequisites / notice

Notice:

The registration is limited to 26 students
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/courses/phri.html

227-0689-00L System Identification

W 4 credits 2V+1U R. Smith

Abstract

Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data.

To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity.
Content

Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models.

Predictive, open-loop, black-box identification methods. Time and frequency domain methods. Subspace identification methods.

Optimal experimental design, Cramer-Rao bounds, input signal design.

Parametric identification methods. On-line and batch approaches.

Literature

Closed-loop identification strategies. Trade-off between controller performance and information available for identification.


Prerequisites / notice

Control systems (227-0216-00L) or equivalent.

227-0517-00L Electrical Drive Systems II

Abstract

In the course “Drive System II” the power semiconductors are repeated. The creation of converters based on the combination of switches/cells and based topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions.

Further topics are the control of the synchronous machine, of line-side converters and issues with converter-fed machines.

Objective

The students establish a deeper understanding in regards of the design of the main components of an electrical drive system. They establish knowledge on the most important interaction with the grid and the machine and their related high dynamic control.

Content

Converter topologies (switch or cell based), multi-pulse diode rectifiers, system aspects of transformer and electrical machines, 3-level inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent magnet machines), control of line-side converters, reflection effects with power cables, winding isolation and bearing stress. Field trip to ABB Semiconductors.

Lecture notes

Skript is sold at the beginning of the lectures or can be downloaded from Ilias

Literature

Skript of lecture; References in skript to related technical publications and books

Prerequisites / notice

Prerequisites: Electrical Drive Systems I (recommended), Basics in electrical engineering, power electronics, automation and mechatronics

151-0107-20L High Performance Computing for Science and Engineering (HPCSE I)

Abstract

This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective

Introduction to HPC for scientists and engineers

Fundamental of:

1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content

Programming models and languages:

1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:

1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes

http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

Class notes, handouts

151-0655-00L Skills for Creativity and Innovation

Abstract

This lecture aims to enhance the knowledge and competency of students regarding their innovation capability. An overview on prerequisites of and different skills for creativity and innovation in individual & team settings is given. The focus of this lecture is clearly on building competencies - not just acquiring knowledge.

Objective

- Basic knowledge about creativity and skills
- Knowledge about individual prerequisites for creativity
- Development of individual skills for creativity
- Knowledge about teams
- Development of team-oriented skills for creativity
- Knowledge and know-how about transfer to idea generation teams

Content

Basic knowledge about creativity and skills:

- Introduction into creativity & innovation: definitions and models

Knowledge about individual prerequisites for creativity:

- Personality, motivation, intelligence

Development of individual skills for creativity:

- Focus on creativity as problem analysis & solving
- Individual skills in theoretical models
- Individual competencies: exercises and reflection

Knowledge about teams:

- Definitions and models
- Roles in innovation processes

Development of team-oriented skills for creativity:

- Idea generation and development in teams
- Cooperation & communication in innovation teams

Knowledge and know-how about transfer to idea generation teams:

- Self-reflection & development planning
- Methods of knowledge transfer
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related materials. A document containing theory, background and practical course content is distributed at the first meeting of the course.

### Micro & Nanosystems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0620-00L</td>
<td>Embedded MEMS Labs</td>
<td>W</td>
<td>5</td>
<td>3P</td>
<td>C. Hierold, S. Blunier, M. Haluska</td>
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</tbody>
</table>

**Abstract**

Practical course: Students are introduced to the process steps required for the fabrication of MEMS (Micro Electro Mechanical System) and carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access allowed:

- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization of the MEMS is documented and evaluated in a final report.

**Objective**

Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

**Content**

With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerometer are carried out:

- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

**Lecture notes**

A document containing theory, background and practical course content is distributed at the first meeting of the course.

**Literature**

The document provides sufficient information for the participants to successfully participate in the course.

**Prerequisites / notice**

Participating students are required to attend all scheduled lectures and meetings of the course.

Participating students are required to provide proof that they have personal accident insurance prior to the start of the laboratory portion of the course.

This master's level course is limited to 15 students per semester for safety and efficiency reasons. If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

**Priority 1:** master students of the master's program in "Micro and Nanosystems"

**Priority 2:** master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MAVT-tutors Prof. Daraio, D. Hierold, Koumoutsakos, Nelson, Norris, Park, Foulkakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

**Priority 3:** master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

**Priority 4:** all other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.
Abstract
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

Self-assembly and directed assembly of 2D and 3D structures.

Special emphasis is placed on the emerging field of molecular electronic devices.

Familiarize students with basic science and engineering principles governing the nano domain.

The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum

From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale

Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

Self-assembly and directed assembly of 2D and 3D structures.

Literature

Prerequisites / notice
Course format:
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.
Content
Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis

Lecture notes
Comprehensive copy of transparencies

<table>
<thead>
<tr>
<th>151-0917-00L</th>
<th>Mass Transfer</th>
<th>W</th>
<th>4 credits</th>
<th>2V+2U</th>
<th>R. Büchel, S. E. Pratsinis</th>
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</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.</td>
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<tr>
<td>Content</td>
<td>Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions, mass transfer and first order heterogenous reaction. Applications.</td>
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<td>Prerequisites / notice</td>
<td>Three tests are offered for practicing the course material. Participation is voluntary.</td>
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<tr>
<th>151-0911-00L</th>
<th>Introduction to Plasmonics</th>
<th>W</th>
<th>4 credits</th>
<th>2V+1U</th>
<th>D. J. Norris</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.</td>
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<tr>
<td>Objective</td>
<td>Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.</td>
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<tr>
<td>Content</td>
<td>Fundamentals of Plasmonics</td>
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<td>- Basic electromagnetic theory</td>
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<td>- Optical properties of metals</td>
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<td>- Surface plasmon polaritons on surfaces</td>
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<td>- Surface plasmon polariton propagation</td>
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<td>- Localized surface plasmons</td>
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<td>Applications of Plasmonics</td>
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<td>- Waveguides</td>
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<td>- Extraordinary optical transmission</td>
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<td>- Enhanced spectroscopy</td>
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<td>- Sensing</td>
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<td>- Metamaterials</td>
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<td>Prerequisites / notice</td>
<td>Physics I, Physics II</td>
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<tr>
<td>Abstract</td>
<td>This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.</td>
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<tr>
<td>Objective</td>
<td>Introduction to HPC for scientists and engineers</td>
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<tr>
<td>Content</td>
<td>Fundamental of:</td>
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<tr>
<td></td>
<td>1. Parallel Computing Architectures</td>
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<td>2. MultiCores</td>
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<td>3. ManyCores</td>
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<td>Programming models and languages:</td>
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<td></td>
<td>1. C++ threading (2 weeks)</td>
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<td>2. OpenMP (4 weeks)</td>
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<td>3. MPI (5 weeks)</td>
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<td>Computers and methods:</td>
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<td></td>
<td>1. Hardware and architectures</td>
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<td>2. Libraries</td>
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<td>3. Particles: N-body solvers</td>
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<td>4. Fields: PDEs</td>
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<td>5. Stochastics: Monte Carlo</td>
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<tr>
<td>Lecture notes</td>
<td><a href="http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1">http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1</a></td>
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<tr>
<th>151-0104-00L</th>
<th>Uncertainty Quantification for Engineering &amp; Life Sciences</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>J. Beck, P. Koumoutsakos</th>
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<tr>
<td>Abstract</td>
<td>Number of participants limited to 60.</td>
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<tr>
<td>Objective</td>
<td>The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicores architecture.</td>
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<td>Content</td>
<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
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<td>Lecture notes</td>
<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
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Bioengineering

<table>
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<tr>
<th>Number</th>
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<td>for Science and Engineering</td>
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<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
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<td>Transport in Biosystems</td>
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<td>151-0317-00L</td>
<td>Visualization, Simulation</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Kunz</td>
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<td>and Interaction - Virtual</td>
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<td>Reality II</td>
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</table>

Abstract

Introduction to HPC for scientists and engineers

Objective

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content

Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.
Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques are introduced, and the course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

227-0386-00L Biomedical Engineering

Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course focuses on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course covers an overview of the various topics of the different tracks of the biomedical imaging master course and helps orienting the students in selecting their specialized classes and project locations.

Content

Lecture notes
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/ibb/Education/BME

227-0447-00L Image Analysis and Computer Vision

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites
Prerequisites:
- Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.
- The course language is English.

227-0945-00L Cell and Molecular Biology for Engineers

Abstract
This course is part of a two-semester course. The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

Objective
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content
In addition, three journal clubs will be held, where one/two publications will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.

Lecture notes
Scripts of all lectures will be available.

Literature

227-0965-00L Micro and Nano-Tomography of Biological Tissues

Abstract
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Objective
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes
Available online

Literature
Will be indicated during the lecture.

**376-1219-00L Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions**

**W 3 credits 2V**

R. Riener, R. Gassert, L. Marchal Crespo

**Abstract**
Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

**Objective**
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

**Content**
- Introduction, problem definition, overview
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
- Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
- Rehabilitation and use of kinesthetic and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
- Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g., BrainPort)
- Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
  - Brain stimulation and recording
  - Deep brain stimulation for patients with Parkinson, epilepsy, depression
  - Brain-Computer Interfaces
Virtual Reality in Medicine

Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
Students of other departments, faculties, courses are also welcome

376-1279-00L Virtual Reality in Medicine W 3 credits 2V R. Riener, M. Harders

Prerequisites / notice
VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

Selected Journal Articles and Web Links:


Additional Resources:

- VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de-sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://eduhaptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/vertical coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

The course language is English.

Lecture notes will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Prerequisites

The course language is English. Basic experience in Information Technology and Computer Science will be of advantage. More details will be announced in the lecture.

Lecture notes

Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Number of participants limited to 26.
Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts can be accessed online.

Literature
(available online via ETH library)

Handouts provided during the classes and references therein.

376-1985-00L Trauma Biomechanics

Abstract
Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

Objective
Introduction to the basic principles of trauma biomechanics.

Content
This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

Lecture notes
Available via homepage.

Literature

402-0341-00L Medical Physics I

Abstract
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Objective
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

Content
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Lecture notes
A script will be provided.

551-0319-00L Cellular Biochemistry (Part I)

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

227-0981-00L Cross-Disciplinary Research and Development in Medicine and Engineering

Abstract
A maximum of 12 medical degree students and 12 (biomedical) engineering degree students can be admitted, their number should be equal.
Abstract
Cross-disciplinary collaboration between engineers and medical doctors is indispensable for innovation in health care. This course will bring together engineering students from ETH Zurich and medical students from the University of Zurich to experience the rewards and challenges of such interdisciplinary work in a project based learning environment.

Objective
The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since such differences become the most evident during actual collaborative work, the course is based on a current project in physiology research that combines medicine and engineering. For the engineering students, the specific aims of the course are to:

- Acquire a working understanding of the anatomy and physiology of the investigated system;
- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.

Content
After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team presenting their solution to a cross-disciplinary audience.

Lecture notes
Handouts and relevant literature will be provided.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1651-00L</td>
<td>Clinical and Movement Biomechanics</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>151-3205-00L</td>
<td>Experimental Ergonomics</td>
<td>4</td>
<td>2V+2A</td>
</tr>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>4</td>
<td>3G</td>
</tr>
<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Design Thinking: Human-Centred Solutions to Real World Challenges
Due to didactic reasons, the number of participants is limited to 30.

All interested students are invited to apply for this course by sending a one-page motivation letter until 07.09.2015 to Florian Rittiner (frittiner@ethz.ch).

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

Objective
The purpose of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in multidisciplinary teams to solve a set of design challenges that are organized as a one-week, a three-week, and a six-week project. The final project will be in collaboration with an external project partner.

During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

Content
- Interaction among consumers, environments, behavior, and tasks
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Experimental techniques in assessing human performance and well-being
- Body spaces and functional anthropometry
- Physiological, physical, and cognitive factors in sensation and perception
- Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Prerequisites / notice
Max. number of participants is 15. Experiments and field studies in teams of 2-3 students are obligatory.

Number of participants limited to 60.

Lectures
Handout at the start of the course.

Literature

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

The course covers fundamentals of computational optimization methods in the context of engineering design. It develops skills to formally state and model engineering design tasks as optimization problems and select appropriate methods to solve them.
The lecture and exercises teach the fundamentals of optimization methods in the context of engineering design. After taking the course students will be able to express engineering design problems as formal optimization problems. Students will also be able to select and apply a suitable optimization method given the nature of the optimization model. They will understand the links between simulation, optimization and engineering design in order to design more efficient and performance optimized technical products. The exercises are MATLAB based.

| Objective | The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering. Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures; |
| Lecture notes |  |
| Literature | Various books will be recommended covering the topics discussed in class |
| Prerequisites / notice | Course in continuum mechanics (mandatory), finite element method (recommended) |

## Multidisciplinary Courses
The students are free to choose individually from the entire course offer of ETH Zurich, ETH Lausanne and the Universities of Zurich and St. Gallen.

## Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1002-00L</td>
<td>O</td>
<td>8 credits</td>
<td>17A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Semester Project Mechanical Engineering**

Only for Mechanical Engineering MSc.

The subject of the Semester Project and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

**Abstract**
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

**Objective**
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

## Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1003-00L</td>
<td>O</td>
<td>8 credits</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

**Industrial Internship Mechanical Engineering**
The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

**Abstract**
The main objective of the 12-week internship is to expose master's students to the industrial work environment.

**Objective**
The main objective of the 12-week internship is to expose master's students to the industrial work environment.

## Compulsory Electives in Humanities, Social and Political Sciences

**Recommended GESS compulsory elective courses (Type B) for D-MAVT.**

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

## Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1001-00L</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Master's Thesis Mechanical Engineering**

Only students who fulfill the following criteria are allowed to begin with their Master's Thesis:

- Successful completion of the Bachelor's programme
- Any additional requirements for admission to the degree programme have been fulfilled
- Successful completion of the Semester Project and Industrial Internship (the corresponding credits have been acquired)

**Abstract**
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.
### Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0173-AAL</td>
<td>Linear Algebra I and II</td>
<td>E-</td>
<td>6</td>
<td>13R</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td><strong>Enrolment only for MSc students who need this course as additional admission requirement.</strong></td>
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</tbody>
</table>

**Abstract**
Linear algebra is an indispensable tool of engineering mathematics. The course is an introduction to basic methods and fundamental concepts of linear algebra and its applications to engineering sciences.

**Objective**
After completion of this course, students are able to recognize linear structures and to apply adequate tools from linear algebra in order to solve corresponding problems from theory and applications. In addition, students have a basic knowledge of the software package Matlab.

**Content**
- Linear maps, kernel and image, coordinates and matrices, coordinate transformations, norm of a matrix, orthogonal matrices, eigenvalues and eigenvectors, algebraic and geometric multiplicity, eigenbasis, diagonalizable matrices, symmetric matrices, orthonormal basis, condition number, linear differential equations, Jordan decomposition, singular value decomposition, examples in MATLAB, applications.

**Reading:**
- Gilbert Strang "Introduction to linear algebra", Wellesley-Cambridge Press: Chapters 1-6, 7.1-7.3, 8.1, 8.2, 8.6

**Literature**

<table>
<thead>
<tr>
<th>406-0353-AAL</th>
<th>Analysis III</th>
<th>E-</th>
<th>4</th>
<th>9R</th>
<th>A. Iozzi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Enrolment only for MSc students who need this course as additional admission requirement.</strong></td>
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</tbody>
</table>

**Abstract**
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

**Objective**
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

**Content**
- Laplace Transforms:
  - Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
  - Transforms of Derivatives and Integrals, ODEs
  - Unit Step Function, t-Shifting
  - Short Impulses, Dirac's Delta Function, Partial Fractions
  - Convolution, Integral Equations
  - Differentiation and Integration of Transforms
- Fourier Series, Integrals and Transforms:
  - Fourier Series
  - Functions of Any Period p=2L
  - Even and Odd Functions, Half-Range Expansions
  - Forced Oscillations
  - Approximation by Trigonometric Polynomials
  - Fourier Integral
  - Fourier Cosine and Sine Transform
- Partial Differential Equations:
  - Basic Concepts
  - Modeling: Vibrating String, Wave Equation
  - Solution by separation of variables; use of Fourier series
  - D'Alembert Solution of Wave Equation, Characteristics
  - Heat Equation: Solution by Fourier Series
  - Heat Equation: Solutions by Fourier Integrals and Transforms
  - Modeling Membrane: Two Dimensional Wave Equation
  - Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
  - Solution of PDEs by Laplace Transform

**Literature**

For reference/complement of the Analysis I/II courses:
- Christian Blatter: Ingenieur-Analysis (Download PDF)

### Mechanical Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td></td>
<td>Courses outside the curriculum</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td></td>
<td></td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td></td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td></td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

**ECTS**  
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Evaluative Science

General course offerings in the category Educational Science are listed under “Programme: Educational Science for Teaching Diploma and TC”.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs “Teaching Diploma” or “Teaching Certificate”. It is about learning in childhood and adolescence.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>Thematische Schwerpunkte:</td>
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<td></td>
<td>- Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<td>- Lernformen:</td>
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<td><strong>Prerequisites / Literature</strong></td>
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<td>Folien werden zur Verfügung gestellt.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-05L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td>Number of participants limited to 30.</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td>- Getting to know intelligence tests</td>
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<td></td>
<td>- Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td>- Understand and critically examine information from scientific journals and media</td>
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<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 DZ)</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
</tr>
<tr>
<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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</table>

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

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

Objective
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).

(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1079-00L</td>
<td>Teaching Internship including Examination Lessons Mechanical and Process Engineering</td>
<td>W</td>
<td>6 credits</td>
<td>13P</td>
<td>S. P. Kaufmann, J. Dual</td>
</tr>
</tbody>
</table>

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

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

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

Content
Die Studierenden sammeln Erfahrungen in der Unterrichtsführung, der Auseinandersetzung mit Lernenden, der Klassenbetreuung und der S. P. Kaufmann

Literature
Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Prerequisites / notice
Dieses Unterrichtspraktikum ist für Studierende, die sich ab dem HS 2011 ins DZ eingeschrieben haben. Alle anderen Lehrveranstaltungen des DZ sind erfolgreich abgeschlossen.

Findet verbindlich am Schluss der Ausbildung, vor Ablegung der Prüfungslektion statt!

Further Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-1061-00L</td>
<td>Subject Didactics I for D-MAVT and D-ITET</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>S. P. Kaufmann, J. Dual</td>
</tr>
</tbody>
</table>

Didactical methods in mechanical and electrical engineering. 

Abstract

Objective
- The students can plan, conduct and critically reflect single lessons.
- They orient themselves towards the academic goals and take into account existing knowledge, the professional environment and the ambitions of the students.
- They can apply the basic teaching principles meaningfully in their subject and suitably structure the learning phases.
- They can reduce and present complex technical content such that it is in a form suitable for the students to learn.
- They have considered examples of the common conceptual errors encountered by students.

Content
- Didactic analysis
- Competences and goals
- Preparation and wrap-up of lessons
- Process and structure of a typical lesson
- Teaching techniques (informative introduction to lessons, Advance Organizer, learning assignments, frontal teaching, questions, assignments, feedback)
- Assignments and short tests
- Media and language competence
- Conceptual change, misconceptions,
- Integration of the subcomponents of a lesson.

Literature

Prerequisites / notice

Voraussetzung: Erziehungswissenschaftliche Lehrveranstaltung schon absolviert oder gleichzeitig.

Eine kurze Anleitung steht zur Verfügung.

Der Einsatz von geeigneter Literatur ist Teil des Leistungsauftrages.

Voraussetzung: Beide Fachdidaktik-Lehrveranstaltungen absolviert.

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

### Mechanical and Process Engineering TC - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

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

### ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Examination Block A

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0261-GUL</td>
<td>Analysis I</td>
<td>O</td>
<td>8 credits</td>
<td>5V+4U</td>
<td>U. Lang</td>
</tr>
</tbody>
</table>

**Abstract**
Differential and integral calculus for functions of one and several variables; vector analysis; ordinary differential equations of first and of higher order, systems of ordinary differential equations; power series. The mathematical methods are applied in a large number of examples from mechanics, physics and other areas which are basic to engineering.

**Objective**
Introduction to the mathematical foundations of engineering sciences, as far as concerning differential and integral calculus.

**Lecture notes**
U. Stammbach: Analysis I/II

**Prerequisites / notice**
5. Übungsauflagen (inkl. Multiple Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung. Es wird erwartet, dass Sie mindestens 75% der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
<td>O</td>
<td>4 credits</td>
<td>3G+2U</td>
<td>V. C. Gradinaru</td>
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</tbody>
</table>

**Abstract**
Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.

**Objective**
Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte

**Lecture notes**
K. Nipp / D. Stoffler, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002

**Literature**
K. Nipp / D. Stoffler, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002

### Examination Block B

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>529-3001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>C. Padeste, P. J. Walde, W. R. Caseri</td>
</tr>
</tbody>
</table>

**Abstract**
General Chemistry I: Stoichiometry, atoms, molecules, chemical bond and molecular structure, gases, solutions, chemical equilibrium, solubility, acids and bases, thermodynamics, electrochemistry, kinetics.

**Objective**
Introduction to general and inorganic chemistry.

**Content**
1. Stoichiometry: mole, chemical formulas and equations,
2. The atom (atomic properties and periodic system), the chemical bond (ionic oder covalent), Lewis formulas, resonance, electronegativity and polar bonds, VSEPR-model.
3. Ideal gases: Gas laws, kinetic gas theory.
4. Liquids, solutions, concentration.
5. Chemical equilibrium in the gas phase.
6. Solubility equilibria
8. Thermodynamics: Thermochemistry, enthalpy, entropy, Gibbs energy, Delta G and K, van't Hoff's equation.
9. Electrochemistry: Oxidation number, half-reactions, electrochemical cells, standard potentials and the Nernst equation.

**Literature**

### Examination Block C

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0103-00L</td>
<td>Introduction to Materials Science</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>L. Heyderman, M. Niederberger, P. Uggowitzer</td>
</tr>
</tbody>
</table>

**Abstract**
Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.

**Objective**
Basic concepts in materials science.

**Content**
Contents:
- Atomic structure
- Atomic bonds
- Crystalline structure, perfection - imperfection
- Diffusion
- Mechanical and thermal properties
- Phase diagrams
- Kinetics
- Structural materials
- Electric, magnetic and optical properties of materials
- Materials selection criteria

**Literature**
James F. Shackelford
Introduction to Materials Science for Engineers

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>327-0104-00L</td>
<td>Crystallography</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>M. Fiebig</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction into the fundamental relationships between chemical composition, crystal structure, symmetry and physical properties of solids. Emphasis: group-theoretical introduction into symmetry, discussion of the factors governing the formation of crystal structures, structural dependence of physical properties, fundamentals of experimental techniques probing the crystal structure.

**Objective**
Introduction into the fundamental relationships between chemical composition, crystal structure, symmetry and physical properties of solids.
Content
Symmetry and order: lattices, point groups, space groups.

Crystal chemistry: geometrical, physical and chemical factors governing the formation of crystal structures; close sphere packings; typical basic crystal structures; lattice energy; magnetic crystals; quasicrystals.

Structure/property relationships: Example quartz (piezoelectricity); perowskite and derivative structures (ferroelectrics and high-temperature superconductors); magnetic materials.

Materials characterization: diffraction techniques, optical techniques.

Lecture notes
A script of the lecture until 2014 is available. New script: to be decided.

Literature

Prerequisites / notice
Organisation: Two hours of lectures per week accompanied by one hour of exercises.

Additional Basic Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>327-0105-00L</td>
<td>Introduction to Scientific Practice for Material Scientists I</td>
<td>O</td>
<td>1</td>
<td>1G</td>
<td>S. Morgenthaler Kobas, M. B. Willeke</td>
</tr>
<tr>
<td>Abstract</td>
<td>The students are introduced to the scientific method, as it is applied in research and industry. The students practise acquiring, analysing and synthesising scientific information and data, and communicating their findings in written and oral form.</td>
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<tr>
<td>Objective</td>
<td>Learning Objectives: The students - can protocol lab experiments correctly in a lab journal. - can analyze and present data efficiently. - can write lab reports according to standard scientific criteria. - are familiar with key rhetorical and communication rules for oral presentations. - can create effective oral presentations on scientific content.</td>
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<tr>
<td>Content</td>
<td>Laborjournal führen Datenauswertung Berichte schreiben Präsentationstechnik Prüfungsvorbereitung</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts werden laufend abgegeben.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Koordiniert mit der Lehrveranstaltung &quot;Praktikum I &amp; II&quot;.</td>
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327-0110-00L Research Lab I O 1 credit 1P P. Uggowitzer

Abstract
A first look at the world of materials research

Objective
Get to know the Department: Who is who? What kind of activities take place? What research is being done? Get to know the scientific staff: Who can I ask for help?

First experience in the research laboratory: Increase motivation through instruction

Content
Each student is assigned a tutor (selected by the Department Secretary) for the period of one semester. It is the task of the tutor to introduce his/her students to the world of materials through regular supervision and instruction. Students will accompany the tutor in his/her research work and so gain an insight into research routines.

At the end of the semester students must deliver a report to the leader of the research group. This report is a prerequisite for receiving course credit.

Tutors are also responsible for answering curriculum queries.

Each semester tutors will be re-assigned.

327-0111-00L Practical Laboratory Course I O 6 credits 6P M. B. Willeke, M. R. Dusseiller, S. Morgenthaler Kobas, P. J. Walde

Abstract
Practical introduction into concepts and basic principles of Materials Science and Chemistry. To become acquainted with important chemical and physical methods.

Objective
Practical introduction into concepts and basic principles of Materials Science and Chemistry. To become acquainted with important chemical and physical methods. Close collaboration with the course "Wissenschaftliches Arbeiten" (planning of experiments, writing reports, techniques for oral presentations). General introduction at the beginning of the practical laboratory course I about safety and general behaviour in the laboratory.

Content
Content: Experiments in the field of synthetic and analytical chemistry, fracture mechanics, mechanical/thermal properties, surface techniques, thermodynamics, nanotechniques as well as corrosion and electroplating.

Lecture notes
The lab manual and further information for each experiment (aim of the experiment, theory, experimental procedure, data analysis) can be downloaded from the web (https://praktikum.mat.ethz.ch bzw. http://www.mat.ethz.ch/education/bachelor_degree/lab_courses).

401-0261-KOL Analysis I E- 0 credits 1K U. Lang

Abstract
Tutorial for Analysis I

4. Semester

3. Semester

Basic Courses Part 2

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction into the most important spectroscopical methods and their applications to gain structural information.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications</td>
<td></td>
<td></td>
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</tbody>
</table>
Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch "Biology" (Campbell & Rees, 7th edition, Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation)


The Vorlesung "Physik II" ist eine Einführung in die Quantenmechanik und Atomphysik. Inhalt:

1. Wahrscheinlichkeit und Wellen-Packet (De-Broglie): Die Phasenwellenfunktion, Postulat 1 (De-Broglie); Die Wellenfunktion, Postulat 2: M. Born, Postulat 3: Das Superpositionsprinzip, die Wellenfunktion.
3. Matrizentheorie (Teilchen im Kasten, Der Tunneleneffekt, Der QM harmonische Oszillator).
4. Bewegung im Zentralfeld
5. Der Drehimpulsoperator (Darstellung von Zuständen und Operatoren, Matrixdarstellung des Drehimpulsoperators, Das Stern-Gerlach Experiment: der Spin, Die Addition von Drehimpulsen in der Quantenmechanik)
7. Mehr-Teilchen Systeme (Das Energiespektrum des He-Atoms, Angeregte Zustände des Heliumatoms, Das Mendeleewische Periodensystem, Spektraltermene)
8. Übergang in Folge einer zeitabhängigen, periodischen Störung (Magnetische Resonanz (I. Rabi, Phys. Rev. 51, 652 (1937), Nobel Preis 1944), Verallgemeinerung der Rabi Formel auf Übergänge in Folge einer zeitabhängigen, periodischen Störung)

Ein Skript wird verteilt.

Lecture notes

Prerequisites / notice

Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

420-0041-00L Organic Chemistry in Materials Science O 2 credits 1G W. R. Caseri, P. J. Walde

The course treats the fundamental aspects of Quantum mechanics and Atomic physics.

Objective

Consolidation of the basics of organic chemistry.

Content

This lecture allows the students to consolidate the basics of organic chemistry through selected exercises.

Prerequisites:

Physics I.

Lecture notes

Script will be for the production price

Literature

- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 6. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice

Excercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

551-0015-00L Biology I O 2 credits 2V R. Glockshuber, E. Hafen

The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.

Objective

The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.

Content

The following Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch "Biology" (Campbell & Rees, 7th edition, 2005)

Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt

1. Aufbau der Zelle

Kapitel 5: Struktur und Funktion biologischer Makromoleküle
Kapitel 6: Eine Tour durch die Zelle
Kapitel 7: Membranstruktur und funktion
Kapitel 8: Moderne Darmarbeit, Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.

2. Allgemeine Genetik

Kapitel 10: Photosynthese
Kapitel 11: Der Zellzyklus
Kapitel 17: Vom Gen zum Protein

3. Der Drehimpulsoperator (Darstellung von Zuständen und Operatoren, Matrixdarstellung des Drehimpulsoperators, Das Stern-Gerlach Experiment: der Spin, Die Addition von Drehimpulsen in der Quantenmechanik)


5. Mehr-Teilchen Systeme (Das Energiespektrum des He-Atoms, Angeregte Zustände des Heliumatoms, Das Mendeleewische Periodensystem, Spektraltermene)

6. Übergang in Folge einer zeitabhängigen, periodischen Störung (Magnetische Resonanz (I. Rabi, Phys. Rev. 51, 652 (1937), Nobel Preis 1944), Verallgemeinerung der Rabi Formel auf Übergänge in Folge einer zeitabhängigen, periodischen Störung)

Ein Skript wird verteilt.

Lecture notes

Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.
Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:


### Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0603-00L</td>
<td>Stochastics (Probability and Statistics)</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>J. Teichmann</td>
</tr>
</tbody>
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**Abstract**
This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.

**Objective**
Knowledge of the basic principles of probability and statistics.

**Content**
Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.

**Lecture notes**
Lecture notes

**Literature**
Lecture notes

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0363-10L</td>
<td>Analysis III</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>A. lozzi</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

**Objective**
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

**Content**
Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates; Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

**Literature**
For reference/complement of the Analysis I/II courses:
Christian Blatter: Ingenieur-Analysis (Download PDF)
Up-to-date information about this course can be found at:
http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet

### Examination Block 3

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0308-00L</td>
<td>Programming Techniques in Materials Science</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>C. Ederer</td>
</tr>
</tbody>
</table>

**Abstract**
This course introduces the general computing and programming skills which are necessary to perform numerical computations and simulations in materials science. This is achieved using the numerical computing environment Matlab and through the use of many practical examples and exercises.

**Objective**
On passing this course, the students should be able to develop their own programs for performing numerical computations and simulations, and they should be able to analyse and amend existing code.

**Content**
Introduction to Matlab; input/output; structured programming using loops and conditional execution; modular Programming using functions; flow diagrams; numerical accuracy; example: random walk model.

### Examination Block 3

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>327-0301-00L</td>
<td>Materials Science I</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>J. F. Löftler, A. R. Studart, P. Uggowitzer</td>
</tr>
</tbody>
</table>

**Abstract**
Basic concepts of metal physics, ceramics, polymers and their technology.

**Objective**
Based on the lecture 'Introduction to Materials Science' this lecture aims to give a detailed understanding of important aspects of materials science, with special emphasis on metallic and ceramic materials.
Thermodynamics and phase diagrams, crystal interfaces and microstructure, diffusional transformations in solids, and diffusionless transformations will be presented for metallic alloys. The basics of the ionic and covalent chemical bonds, the bond energy, the crystalline structure, four important structural ceramics, and the properties of glasses and glass ceramics will be presented for ceramic materials.

For metals see: http://www.methphys.mat.ethz.ch/education/courses/mat_wiss1/details

For ceramics see: http://www.complex.mat.ethz.ch/education/lectures.html

Metals:
- D. A. Porter, K. E. Easterling
  Phase Transformations in Metals and Alloys - Second Edition
  ISBN: 0-7487-5741-4
  Nelson Thornes

Ceramics:
- Munz, D.; Fett, T: Ceramics, Mechanical Properties, Failure Behaviour, Materials Selection,
- diverse CEN ISO Standards given in the slides
- Barsoum MW: Fundamentals of Ceramics:
- "Brevieral Ceramics" published by the "Verband der Keramischen Industrie e.V.", ISBN 3-924158-77-0, partly its contents may be found in the internet @ http://www.keramverband.de/brevier_engl/brevier.htm or on our homepage

Additional Basic Courses

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>327-0311-00L</td>
<td>Practical Laboratory Course III</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>M. B. Willeke, J. Patscheider, S. Pokrant, P. J. Walde</td>
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</table>

Bacheler Studies (Programme Regulations 2012)
3. Semester
Basic Courses Part 2
Examination Block 1

<table>
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<tr>
<th>Number</th>
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<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
</tbody>
</table>

**Lecture notes**

Script will be for the production price

**Literature**

- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

**Prerequisites / notice**

Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

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**402-0041-00L**  
**Physics II**  
**O**  
7 credits  
4V+2U  
D. Pesca

**Abstract**

The course treats the fundamental aspects of Quantum mechanics and Atomic physics.

**Objective**

Ziel dieser Vorlesung ist es, die grundlegenden Experimente zu kennen sowie die dazugehörende Theorie zu verstehen und sie in einfachen Problemstellungen zur Anwendung zu bringen.

**Content**

Die Vorlesung "Physik II" ist eine Einführung in die Quantenmechanik und Atomphysik.

- Eindimensionale Probleme (Teilchen im Kasten, Der Tunneleffekt, Der QM harmonische Oszillator)
- Bewegung im Zentralfeld
- Der Drehimpulsoperator (Darstellung von Zuständen und Operatoren, Matrixdarstellung des Drehimpulseoperators, Das Stern-Gerlach Experiment; der Spin, Die Addition von Drehimpulsen in der Quantenmechanik)
- Mehr-Teilchen Systeme (Das Energiespektrum des He-Atoms, Angeregte Zustände des Heliumatoms, Das Mendelejeusche Periodensystem, Spektralterme)
- Übergang in Folge einer zeitabhängigen, periodischen Störung (Magnetische Resonanz (I. Rabi, Phys. Rev. 51, 652 (1937), Nobel Preis 1944), Verallgemeinerung der Rabi Formel auf Übergänge in Folge einer zeitabhängigen, periodischen Störung)

**Lecture notes**

Ein Skript wird verteilt.

**Prerequisites / notice**

Prerequisites: Physics I.

---

**401-0603-00L**  
**Stochastics (Probability and Statistics)**  
**O**  
4 credits  
2V+1U  
J. Teichmann

**Abstract**

This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.

**Objective**

Knowledge of the basic principles of probability and statistics.

**Content**

Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.

**Lecture notes**

Lecture notes

**Literature**

Lecture notes

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**401-0363-10L**  
**Analysis III**  
**O**  
3 credits  
2V+1U  
A. Iozzi

**Abstract**

Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

**Objective**

Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

**Content**

Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

---
The students should be able to develop their own programs for performing numerical computations and simulations.

Prerequisites:

- Up-to-date information about this course can be found at:
  [http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet](http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet)

Objective:

On passing this course, the students should be able to develop their own programs for performing numerical computations and simulations, and they should be able to analyse and amend existing code.

Content:

- Introduction to Matlab; input/output; structured programming using loops and conditional execution; modular Programming using functions;
- flow diagrams; numerical accuracy; example: random walk model.

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### Examination Block 3

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<tr>
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<tr>
<td>327-0301-00L</td>
<td>Materials Science</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>J. F. Löfler, A. R. Studart, P. Uggowitzer</td>
</tr>
</tbody>
</table>

**Abstract:**

Basic concepts of metal physics, ceramics, polymers, and their technology.

**Objective:**

Based on the lecture 'Introduction to Materials Science' this lecture aims to give a detailed understanding of important aspects of materials science, with special emphasis on metallic and ceramic materials.

**Content:**

- Phase Transformations in Metals and Alloys - Second Edition
- Nelson Thornes

For ceramics see:

- "Brevieral Ceramics" published by the "Verband der Keramischen Industrie e.V.", ISBN 3-924158-77-0. partly its contents may be found in the internet @ http://www.keramverband.de/brevier_engl/brevier.htm or on our homepage
- Silicon-Based Structural Ceramics (Ceramic Transactions), Stephen C. Danforth (Editor), Brian W. Sheldon, American Ceramic Society, 2003,

**Literature**

- Silicon-Based Structural Ceramics (Ceramic Transactions), Stephen C. Danforth (Editor), Brian W. Sheldon, American Ceramic Society, 2003,
- Phase relationships in the zirconia-ytrria system, HGM Scott - Journal of Materials Science, 1975, Springer

- In the first part of the lecture the bases are obtained for metals. In the second part the basics of cermics will be presented.
- The lecture will be generally in German.

**Prerequisites:**

- In the first part of the lecture the bases are obtained for metals. In the second part the basics of cermics will be presented.
- The lecture will be generally in German.
Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch "Biology" (Campbell & Rees, 7th edition, 2005)
Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt

1. Aufbau der Zelle
   - Kapitel 5: Struktur und Funktion biologischer Makromoleküle
   - Kapitel 6: Eine Tour durch die Zelle
   - Kapitel 7: Membranstruktur und -funktion
   - Kapitel 8: Einführung in den Stoffwechsel
   - Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie
   - Kapitel 10: Photosynthese
   - Kapitel 12: Der Zellzyklus
   - Kapitel 17: Vom Gen zum Protein

2. Allgemeine Genetik
   - Kapitel 13: Meiose und Reproduktionszyklen
   - Kapitel 14: Mendel'sche Genetik
   - Kapitel 15: Die chromosomale Basis der Vererbung
   - Kapitel 16: Die molekulare Grundlage der Vererbung
   - Kapitel 18: Genetik von Bakterien und Viren
   - Kapitel 46: Tierische Reproduktion

Lecture notes
Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.

Literature
Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:

Prerequisites / notice

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## Additional Basic Courses

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>327-0311-00L</td>
<td>Practical Laboratory Course III</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>M. B. Willeke, J. Patscheider, S. Pokrant, P. J. Walde</td>
</tr>
</tbody>
</table>

Abstract
To impart basic knowledge and experimental competence using selected examples from chemistry and physics.

Objective
To impart basic knowledge and experimental competence using selected examples from chemistry and physics.

Content
Chemistry III: Synthesis of PMMA via Transesterification; manufacture of poly(methylmethacrylat) via radical polymerization of methylmethacrylat; 3D-printing. Physics I: Powder diffractometry, single crystal radiography, capillary rheometry, viscoelasticity of the polymer melt (or an equivalent exp.); 2 physics Experiment at the EMPA: e.g. X-ray fluorescence analysis, impedance measurements of batteries, cathode manufacturing for a Li-ion battery or texture measurement; and two further physic experiments at D-Phys (e.g. about "elastic constants" or "Inference and diffraction").

Lecture notes
Notes with information for each experiment (aim of the experiment, theory, experimental procedure, data analysis) can be downloaded from the web (https://praktikum.mat.ethz.ch or http://www.mat.ethz.ch/education/bachelor_degree/lab_courses).

Prerequisites / notice

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## 5. Semester

### Basic Courses Part 2

#### Examination Block 5

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>327-0407-00L</td>
<td>Basic Principles of Materials Physics B</td>
<td>O</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>P. Gambardella</td>
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</tbody>
</table>

Abstract
This course introduces classical and quantum mechanical concepts for the understanding of material properties from a microscopic point of view. The lectures focus on the static and dynamic properties of crystals, the formation of chemical bonds and electronic bands in molecules, insulators, metals, and semiconductors, and on the thermal and electrical properties that emerge from this analysis.

Objective
Providing physical concepts for the understanding of material properties:

Understanding the electronic properties of solids is at the heart of modern society and technology. The aim of this course is to provide fundamental concepts that allow the student to relate the microscopic structure of matter and the quantum mechanical behavior of electrons to the macroscopic properties of materials. Beyond fundamental curiosity, such level of understanding is required in order to develop and appropriately describe new classes of materials for future technology applications. By the end of the course the student should have developed a semi-quantitative understanding of basic concepts in solid state physics and be able to appreciate the pertinence of different models to the description of specific material properties.
PART I: Structure of solid matter, real and reciprocal space

The crystal lattice, Bravais lattices, primitive cells and unit cells, Wigner-Seitz cell, primitive lattice vectors, lattice with a basis, examples of 3D and 2D lattices.

Fourier transforms and reciprocal space, reciprocal lattice vectors, Brillouin zones


PART II: Dynamics of atoms in crystals

Lattice vibrations and phonons in 1D, phonons in 1D chains with monoatomic basis, phonon in 1D chains with a diatomic basis, optical and acoustic modes, phase and group velocities, phonon dispersion and eigenvectors. Phonons in 2D and 3D.

Quantum mechanical description of lattice waves in solids, the harmonic oscillator, the concept of phonon, phonon statistics, Bose-Einstein distribution, phonon density of states, Debye and Einstein models, thermal energy, heat capacity of solids.

PART III: Electron states and energy bands in molecules and solids

Electronic properties of materials, classical concepts: electrical conductivity, Hall effect, thermoelectric effects. Drude model. Transition to quantum models and review of quantum mechanical concepts.

Introduction to molecular orbital theory and linear combination of atomic orbitals (LCAO). The H2+ molecule, homonuclear and heteronuclear molecules, benzene, sigma and pi bonds, sp3 and sp2 hybridization. From molecules to periodic crystal structures.

The free electron gas: Fermi statistics, Fermi energy and Fermi surface, density of states in k-space and as a function of energy. Inadequacy of the free electron model.


PART IV: Electrical and heat conduction

Dynamics of electrons in energy bands, phase and group velocity, crystal momentum, the effective mass concept, scattering phenomena. The equilibrium and non-equilibrium distribution function for electrons. The Boltzmann equation in the presence of external fields in the relaxation time approximation.

Electrical and thermal conductivities revisited. Electron transport due to electric fields (drift) and concentration gradients (diffusion). Einstein's relations. Transport of heat by electrons, Seebeck effect and thermopower, Peltier effect, thermoelectric cooling, thermoelectric energy conversion.

PART V: Semiconductors: concepts and devices

### Metals I

**Abstract**
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

**Objective**
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

**Content**
Dislocation theory:
- Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations
- Hardening theory:
  - a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
  - b. particle hardening: case studies on aluminium-copper alloys
- High temperature plasticity:
  - thermally activated glide
  - power-law creep
  - diffusional creep: Coble, Nabarro-Herring
  - deformation mechanism maps
  - Case studies in turbine blades
- Superplasticity
- Alloying effects

**Lecture notes**
https://www.met.mat.ethz.ch/education/lect_scripts

**Literature**
- Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
- Haasen, Physikalische Metallkunde, Springer Verlag
- Rösler/Hardeners/Bäker, Mechanisches Verhalten der Werkstoffe, Teubner Verlag
- Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
- Hull/Bacon, Introduction to Dislocations, Butterworth & Heinemann
- Courtney, Mechanical Behaviour of Materials, McGraw-Hill

### Polymers I

**Abstract**
Physical foundations of single polymer molecules and interacting chains.

**Objective**
The course offers a modern approach to the understanding of universal static and dynamic properties of polymers.

**Content**
- Polymer Physics:
  1. Introduction to Polymer Physics, Random Walks
  2. Excluded Volume
  3. Structure Factor from Scattering Experiments
  4. Persistence
  5. Solvent and Temperature Effects
  6. Flory theory
  7. Self-consistent field theory
  8. Interacting Chains, Phase Separation and Critical Phenomena
  9. Rheology
  10. Numerical methods in polymer physics, computer experiments

**Lecture notes**
A script can be found at http://www.polyphys.mat.ethz.ch/education/polymer_physics

**Literature**

**Prerequisites / notice**
Computer experiments will use the simple MATLAB programming language and will be made available, if necessary or useful.

### Ceramics I

**Abstract**
Introduction to ceramic processing.

**Objective**
The aim is the understanding of the basic principles of ceramic processing.

**Content**
- Basic chemical processes for powder production.
- Liquid-phase synthesis methods.
- Sol-Gel processes.
- Classical crystallization theory.
- Gas phase reactions.
- Basics of the colloidal chemistry for suspension preparation and control.
- Characterization techniques for powders and colloids.
- Shaping techniques for bulk components and thin films.
- Sintering processes and microstructural control.

**Lecture notes**
See: https://www.multimat.mat.ethz.ch/education/courses/ceramics1

**Literature**
Books and references will be given on the lecture notes.

### Biological and Bio-inspired Materials

**Abstract**
The aim of this course is to impart knowledge on the underlying principles governing the design of biological materials and on strategies to fabricate synthetic model systems whose structural organization resembles those of natural materials.

**Objective**
The course first offers a comprehensive introduction to evolutive aspects of materials design in nature and a general overview about the most common biopolymers and biominerals found in biological materials. Next, current approaches to fabricate bio-inspired materials are presented, followed by a detailed evaluation of their structure-property relationships with focus on mechanical, optical, surface and adaptive properties.
This course is structured in 3 blocks:

Block (I): Fundamentals of engineering in biological materials
- Biological engineering principles
- Basic building blocks found in biological materials

Block (II): Replicating biological design principles in synthetic materials
- Biological and bio-inspired materials: polymer-reinforced and ceramic-toughened composites
- Lightweight biological and bio-inspired materials
- Functional biological and bio-inspired materials: surfaces, self-healing and adaptive materials

Block (III): Bio-inspired design and systems
- Bio-inspiration in the building environment
- Future developments in bio-inspired materials

Lecture notes
Copies of the slides will be made available for download before each lecture.

Literature
The course is mainly based on the books listed below. Additional references will be provided during the lectures.


### Basic Courses Part 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0511-00L</td>
<td>Practical Course V</td>
<td>O</td>
<td>6 credits</td>
<td>8P</td>
<td>M. B. Willeke, J. F. Löfler, P. Uggowitzer</td>
</tr>
</tbody>
</table>

**Abstract**
Acquisition of independent scientific-technical skills; project management; organization and undertaking of experiments; interpretation, scientifically and technically correct project presentation in oral and written form.

**Objective**
Acquisition of independent scientific/technical skills; project management; organization and conducting of experiments; interpretation and scientifically/technically correct presentation of projects in oral and written form.

**Content**
Supervision by DMATL research groups
Groups of students (2 or 3 per group) each work on a research project throughout the semester.

**Prerequisites / notice**
Prerequisite: Successful participation in the "Praktika I - IV" (courses within the material science bachelor study at ETH) or comparable practical lab courses.

### Compensatory Courses

*Only possible after consultation with the Director of Studies.*

#### Industrial Internship or Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0001-00L</td>
<td>Industrial Internship ■</td>
<td>W</td>
<td>10 credits</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

**Abstract**
12 weeks of industrial internship which is completed with a written report.

**Objective**
The main objective of the 12-week internship is to expose bachelor's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0002-00L</td>
<td>Project ■</td>
<td>W</td>
<td>10 credits</td>
<td>21P</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
Carrying out outside of D-MATL: Only possible after consultation with the Director of Studies.

**Objective**
The main objective of the 12-week research project is to expose bachelor's students to the professional research environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

### Compulsory Electives in Humanities, Social and Political Sciences

*Recommended GESS compulsory elective courses (Type B) for D-MATL.*

*see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability*
*see GESS Compulsory Electives: Language Courses ETH/UZH*

#### Materials Science Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

#### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

*Special students and auditors need special permission from the lecturers.*
### Materials Science Master

#### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0505-00L</td>
<td>Surfaces, Interfaces and their Applications I</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>N. Spencer, M. P. Heuberger, L. Isa</td>
</tr>
<tr>
<td>Abstract</td>
<td>After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Introduction to Surface Science Physical Structure of Surfaces Surface Forces (static and dynamic) Adsorbates on Surfaces Surface Thermodynamics and Kinetics The Solid-Liquid Interface Electron Spectroscopy Vibrational Spectroscopy on Surfaces Scanning Probe Microscopy Introduction to Tribology Introduction to Corrosion Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Script Download:</td>
<td></td>
<td></td>
<td></td>
<td><a href="https://www.surface.mat.ethz.ch/education/courses/surfaces_interfaces_and_their_applications_I">https://www.surface.mat.ethz.ch/education/courses/surfaces_interfaces_and_their_applications_I</a></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Chemistry: General undergraduate chemistry including basic chemical kinetics and thermodynamics Physics: General undergraduate physics including basic theory of diffraction and basic knowledge of crystal structures</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>327-1201-00L</td>
<td>Transport Phenomena I</td>
<td>W Dr</td>
<td>4 credits</td>
<td>4G</td>
<td>H. C. Öttinger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Phenomenological approach to “Transport Phenomena” based on balance equations supplemented by thermodynamic considerations to formulate the undetermined fluxes in the local species mass, momentum, and energy balance equations; fundamentals, applications, and simulations</td>
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<tr>
<td>Objective</td>
<td>The teaching goals of this course are on five different levels: (1) Deep understanding of fundamentals: local balance equations, constitutive equations for fluxes, entropy balance, interfaces, idea of dimensionless numbers, ... (2) Ability to use the fundamental concepts in applications (3) Insight into the role of boundary conditions (4) Knowledge of a number of applications (5) Flavor of numerical techniques: finite elements, finite differences, lattice Boltzmann, Brownian dynamics, ...</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>A detailed manuscript is provided; this manuscript will be developed into a book entitled &quot;A Modern Course in Transport Phenomena&quot; by David C. Venerus and Hans Christian Öttinger</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Complex numbers, Vector analysis (integrability; Gauss’ divergence theorem). Laplace and Fourier transforms. Ordinary differential equations (basic ideas). Linear algebra (matrices; functions of matrices; eigenvectors and eigenvalues; eigentfunctions). Probability theory (Gaussian distributions; Poisson distributions; averages; moments; variances; random variables). Numerical mathematics (integration). Equilibrium thermodynamics ( Gibbs’ fundamental equation; thermodynamic potentials; Legendre transforms). Maxwell equations, Programming and simulation techniques (Matlab, Monte Carlo simulations).</td>
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</tr>
<tr>
<td>327-1202-00L</td>
<td>Solid State Physics and Chemistry of Materials I</td>
<td>W Dr</td>
<td>4 credits</td>
<td>4G</td>
<td>N. Spaldin</td>
</tr>
<tr>
<td>Abstract</td>
<td>In this course we study how the properties of solids are determined from the chemistry and arrangement of the constituent atoms, with a focus on materials that are not well described by conventional band theories because their behavior is governed by strong quantum-mechanical interactions.</td>
<td></td>
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<tr>
<td>Content</td>
<td>In this course we study how the properties of solids are determined from the chemistry and arrangement of the constituent atoms, with a focus on materials that are not well described by conventional band theories because their behavior is governed by strong quantum-mechanical interactions. We begin with a review of the successes of band theory in describing many properties of metals, semiconductors and insulators, and we practise building up band structures from atoms and describing the resulting properties. Then we explore classes of systems in which the coupling between the electrons and the lattice is so strong that it drives structural distortions such as Peierls instabilities, John-Teller distortions, and ferroelectric transitions. Next, we move on to strong couplings between electronic charge and spin- and/or orbital- angular momentum, yielding materials with novel magnetic properties. We end with examples of the complete breakdown of single-particle band theory in so-called strongly correlated materials, which comprise for example heavy-fermion materials, frustrated magnets, materials with unusual metal-insulator transitions and the high-temperature superconductors.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Hand-outs with additional reading will be made available during the course.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
 Introduction to materials synthesis concepts based on the assembly of differently shaped objects of varying chemical nature and length scales

**Teaching goals:**

Advanced Composite and Adaptive Material Systems

Students should be able to learn which experimental tools may help to troubleshoot a problem. A key aspect is that students should learn

**ECTS:** 4 credits

**Type:** Manufacturing, Engineering & Technology

**Lecturers:** J. Vermant, F. J. Clemens, M. Niederberger

**Prerequisites / notice**

Soft Materials II

327-1203-00L

Complex Materials I: Synthesis & Assembly

W Dr 4 credits 4G

M. Niederberger, D. Koziej

**Abstract**

Introduction to materials synthesis concepts based on the assembly of differently shaped objects of varying chemical nature and length scales

**Objective**

The aim is a) to learn how to design and create objects as building blocks with a particular shape and a defined recognition pattern, b) to understand the chemistry that allows for the creation of such hard and soft objects within a certain size range, and c) to master the concepts to assemble these objects into hierarchically structured materials.

**Content**

The course is divided into two parts: I) synthesis of 0-, 1-, 2-, and 3-dimensional building blocks with a length scale from nm to µm, and II) assembly of these building blocks into 1-, 2- and 3-dimensional structures over several length scales up to cm.

In part I, various methodologies for the synthesis of the building blocks will be discussed, including Turkevich and Brust-Schiffrin-method for gold nanoparticles, hot-injection for semiconducting quantum dots, aqueous and nonaqueous sol-gel chemistry for metal oxides, or gas- and liquid-phase routes to carbon nanostructures.

Part II is focused on self- and directed assembly methods that can be used to create higher order architectures from those building blocks connecting the microscopic with the macroscopic world. Examples include photonic crystals, nanocrystal solids, colloidal molecules, mesocrystals or particle-based foams and aerogels.

**Lecture notes**

http://www.multimat.mat.ethz.ch/education/courses/materials_synthesis

**Literature**

References to original articles and reviews for further reading will be provided on the lecture notes.

**Prerequisites / notice**

1) Einführung Materialwissenschaft (327-0103-00L), in particular atomic structure, chemical bonds and basics of magnetic, electronic and optical properties of materials
2) Ceramics I (327-0503-00L), in particular liquid-phase processes, sol-gel processes and interparticle interactions
3) Kristallographie (327-0104-00L), in particular structure of crystalline solids
4) Methoden der Materialcharakterisierung (327-0504-00L)
5) Basic concepts of polymer science, in particular polymer synthesis and polymer characterization

**Abstract**

Materials at Work I

W Dr 4 credits 4S

R. Spolenak, R. Koopmans

**Objective**

Teaching goals:

- to learn how materials are selected for a specific application
- to understand how materials around us are produced and manufactured
- to understand the value chain from raw material to application
- to be exposed to state of the art technologies for processing, joining and shaping
- to be exposed to industry related materials issues and the corresponding language (terminology) and skills
- to create an impression of how a job in industry "works". to improve the perception of the demands of a job in industry

**Content**

This course is designed as a two semester class and the topics reflect the contents covered in both semesters.

Lectures and case studies encompass the following topics:

- Strategic Materials (where do raw materials come from, who owns them, who owns the IP and can they be substituted)
- Materials Selection (what is the optimal material (class) for a specific application)
- Materials systems (subdivisions include all classical materials classes)
- Processing
- Joining (assembly)
- Shaping
- Materials and process scaling (from mm to m and vice versa, from mg to tons)
- Sustainable materials manufacturing (cradle to cradle)
- Recycling (Energy recovery)

After a general part of materials selection, critical materials and materials and design four parts consisting of polymers, metals, ceramics and coatings will be addressed.

In the fall semester the focus is on the general part, polymers and alloy case studies in metals. The course is accompanied by hands-on analysis projects on everyday materials.

**Lecture notes**

https://www.met.mat.ethz.ch/education/lect_scripts

**Literature**

Manufacturing, Engineering & Technology

Serope Kalpakjian, Steven Schmid

ISBN: 978-0131489653

**Prerequisites / notice**

Profound knowledge in Physical Metallurgy and Polymer Basics and Polymer Technology required (These subjects are covered at the Bachelor Level by the following lectures: Metalle 1, 2; Polymere 1,2)

**Abstract**

Soft Materials II

W Dr 4 credits 4G

J. Vermant, L. Isa

**Objective**

In the second part of the course we will introduce the experimental tools to study the materials at the invariably wide range of length scales, which are embedded in the microstructures that generate the desired properties.

Students should be able to learn which experimental tools may help to troubleshoot a problem. A key aspect is that students should learn to see which are the "knobs that can be turned", by playing with the chemistry of the building blocks, the formulation, the physical chemistry or not the process technology.

---

**Elective Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-2103-00L</td>
<td>Advanced Composite and Adaptive Material Systems</td>
<td>W</td>
<td>4</td>
<td>2V+2U</td>
<td>G. P. Terrasi, F. J. Clemens</td>
</tr>
</tbody>
</table>
Enables materials scientists to work in a wide range of advanced composite and adaptive material systems. Emphasis is placed on developing advanced knowledge and understanding of their design, manufacturing, structure and properties, characterisation and applications.

Content

The course will comprise a balance of lectures, tutorials, student presentations and laboratory classes. In addition, case study site visits will be made for certain topics to illustrate the industrial application of particular technologies.

More and more, the interest in functional fibre composites is increasing. In beginning, the main focus will be on the production of functional fibres, e.g., for fibre-based sensor and actuator composites with polymers, metals and ceramics. Optical, piezoelectric, shape memory and other fibres for advanced composite applications will be treated in detail. There will be a discussion on fibre classification, fibre production (ceramic and others), adaptive and smart materials, types of sensors and actuators (e.g., made from electro-active poly-mers), and sensor networks with piezoelectric or other fibres for advanced composite applications.

Crack-flaws cannot be neglected in engineering analysis. Even microscopic crack flaws can grow over time, ultimately resulting in fractured components. Structures that may have been blindly deemed "safe" could fail disastrously, causing injuries to its users, or the loss of life. Fracture mechanics can be used to:

- Predict the rate at which a crack can approach a critical size due to fatigue loads or aggressive environmental conditions
- Determine how large a crack can be in a structure before it leads to catastrophic failure

The topics covered are

- Introduction to Linear Elastic Fracture Mechanics (LEFM): crack tip stress, strain and displacement fields in linear elastic materials (Modes I, II and III); the stress-intensity factor, K; the fracture toughness KIC and their determination; fracture criterion
- Estimates of crack plastic zones in ductile materials
- The compliance method; experimental determination of compliance
- Introduction to fracture mechanics of nonlinear materials: the J-integral; the JIC fracture criterion; JIC testing
- Application of fracture mechanics concepts in the analysis of subcritical crack growth (fatigue, stress corrosion cracking, creep and their combinations)
- Lifetime determination and prediction; failure analysis.

Prerequisites / notice

ETH-course 327-0610 Composite Materials or similar course

Literature


Adaptronics and smart structures: basics, materials, design, and applications by H. Jana. Publisher Springer 1999; Berlin, New York.


New York.

Adaptronics and smart structures : basics, materials, design, and applications by H. Jana. Publisher Springer 1999; Berlin, New York.

Adaptronics and smart structures : basics, materials, design, and applications by H. Jana. Publisher Springer 1999; Berlin, New York.

Adaptronics and smart structures : basics, materials, design, and applications by H. Jana. Publisher Springer 1999; Berlin, New York.
**Content**
This course is structured in 3 blocks:

- **Block (I): Fundamentals of engineering in biological materials**
  - Biological engineering principles
  - Basic building blocks found in biological materials

- **Block (II): Replicating biological design principles in synthetic materials**
  - Biological and bio-inspired materials: polymer-reinforced and ceramic-toughened composites
  - Lightweight biological and bio-inspired materials
  - Functional biological and bio-inspired materials: surfaces, self-healing and adaptive materials

- **Block (III): Bio-inspired design and systems**
  - Bio-inspiration in the building environment
  - Future developments in bio-inspired materials

**Lecture notes**
Copies of the slides will be made available for download before each lecture.

**Literature**
The course is mainly based on the books listed below. Additional references will be provided during the lectures.


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credit Hours</th>
<th>Options</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0702-00L</td>
<td>EM-Practical Course in Materials Science</td>
<td>2 credits</td>
<td>4P</td>
<td>K. Kunze, F. Gramm, F. Krumeich, J. F. Löffler, J. Reuteler, R. A. Wepf</td>
</tr>
<tr>
<td>327-0703-00L</td>
<td>Electron Microscopy in Material Science</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>H. Gross, R. Erni, S. Gerstl, F. Gramm, F. Krumeich, K. Kunze, R. A. Wepf</td>
</tr>
<tr>
<td>327-2105-00L</td>
<td>Supramolecular Aspects of Polymers</td>
<td>2 credits</td>
<td>1G</td>
<td>P. J. Walde</td>
</tr>
<tr>
<td>151-0605-00L</td>
<td>Nanosystems</td>
<td>4 credits</td>
<td>4G</td>
<td>A. Stemmer, J.N. Tisserant</td>
</tr>
</tbody>
</table>

**Abstract**
Practical work on a TEM and on SEM, treatment of typical problems, data analysis, writing of a report

**Objective**
Application of basic electron microscopic techniques to material sciences problems

**Prerequisites / notice**
Prerequisite: the lecture Electron Microscopy (327-0703-00L) has to be attended with success, maximum number of participants 15, work in groups of 3 people.

**Abstract**
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

**Objective**
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

**Content**
This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

**Lecture notes**
Erni: Aberration-corrected imaging in transmission electron microscopy, Imperial College Press (2010, and 2nd ed. 2015)

**Abstract**
Preparation, characterization and applications of polymeric aggregates formed from amphiphilic block copolymers.

**Objective**
To become acquainted with the principles of the self-assembly of amphiphilic block copolymers into micelles and vesicles and to become acquainted with some of the properties and applications of these aggregates.

**Content**
With selected recent examples on the self-assembly of amphiphilic block copolymers several basic aspects and possible applications will be discussed. The focus will mainly be on micelles and vesicles.

**Abstract**
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

**Objective**
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.
Self-assembly and directed assembly of 2D and 3D structures.

**Content**
The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

**Topics**
Topics are treated in 2 blocks:

(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.
Self-assembly and directed assembly of 2D and 3D structures.
Literature


Prerequisites / notice

Course format:
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

402-0313-00L Materials Research Using Synchrotron Radiation

Abstract
The course gives an introduction to the use of synchrotron radiation in materials science. It treats the generation of intense x-ray beams at synchrotron radiation sources and their use for the characterisation of materials properties at different length scales. As part of the course, experiments will be carried out at the Swiss Light Source, Paul Scherrer Institut.

Objective
A comprehensive understanding of the interaction of x-rays with condensed matter and their use in materials analysis; acquiring hands-on experience with the use of synchrotron radiation.

Content
Interaction of x-rays with matter:
- Elastic scattering from bound electron, atom and assemblies of atoms; Compton scattering; principles of diffraction from crystals and scattering from disordered systems; thermal diffuse scattering, small-angle scattering from nanometre-sized objects; X-ray absorption spectroscopy; microscopy; comparison with neutron scattering, where appropriate.

The generation of high-brilliance x-ray beams at synchrotron radiation sources:
- Undulators, wigglers and bending magnets; comparison with conventional lab sources; the future x-ray free electron laser.

Instrumentation:
- Monochromator; diffractometer; detector.

Determination of materials properties:
- Crystal structure; defects and strain fields; structure of surfaces and interfaces; chemical bonding properties.

New methods:
- Coherent x-ray scattering and diffractive imaging.

Lecture notes
A reader and a guide through the experiments at the Swiss Light Source will be made available on the web.

Literature

The lab course has been designed by J. Als-Nielsen in collaboration with staff from the SLS.

Prerequisites / notice
Part of the course is in the form of practical work at the Swiss Light Source. During two days (dates to be agreed), the following experiments will be performed: (1) elastic and Compton scattering, (2) liquid scattering and powder diffraction, and (4) X-ray absorption spectroscopy.

402-0809-00L Introduction to Computational Physics

Abstract
This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions

Content

Prerequisites / notice
Lecture and exercise lessons in english, exams in German or in English

529-0947-00L Basic Polymer Synthesis

Abstract
Chain-growth polymerizations (anionic, cationic, Ziegler/Natta, ROMP, radical, NMP, ATRP, RAFT), mechanistic details including how to render a polymerization "living", recent developments, and important examples.

Objective
The students should gain an overview of practical polymerization procedures, learn how to deal with chemical structures and reactivities, and be able to suggest reasonable synthetic pathways to a given polymer structure. Aspects like achievable molar masses in dependence of the method used and structure perfection play a role throughout.

I. Anionic polymerization

1. General
2. Living polymerization
3. Group transfer polymerization (GTP)
4. Some recent developments

II. Cationic polymerization

1. General
2. Some applications (macromonomer and telechelics)

III. Ziegler/Natta- and metallocene polymerization

1. General
2. Mechanism
3. Some applications

IV. Ring-opening metathesis polymerization

1. Comments on history
2. Monomers, catalysts, polymer structures
3. Mechanism, direct NMR monitoring
4. Termination
5. Examples

V. Controlled radical polymerization

1. Nitroxide mediated polymerization (NMP)
2. Atom transfer radical polymerization (ATRP)
3. Reversible addition fragmentation chain transfer polymerization (RAFT)

For step-growth procedures and other topics (dendrimers, bottle-brushes, macrocycles, polyrotaxanes, topochemical polymerizations etc.) see Advanced Polymer Synthesis

Lecture notes
A script will not be provided. For all projections shown, however, paper copies will be distributed.

Literature
There is no specific literature recommendation. Numerous references will be provided for an easy access to the original literature.

Prerequisites / notice
The course will be taught in English. Complicated expressions will be explained in German. Questions can be asked in both languages. The examination will be in English; answers are acceptable in both languages.

PhD students who need recognized credit points are required to pass the written exam.
Abstract
This course will provide an up-to-date, comprehensive review of the industrial perspective at the interface of biomaterials and drugs. This covers regulatory, clinical, pre-clinical and manufacturing concepts. The presentations are provided in an effort to maximize the interaction of student and lecturer.

Objective
- The student will be able to categorize a drug-biomaterial as a "drug" or a "material" from a regulatory perspective and can summarize general regulatory pathways for material/drug development.
- The student will be able to summarize the current concepts and challenges for the industry at the material-drug interface.
- The student will actively develop innovative, industrial concepts at the drug-biomaterial interface.

Content
This course will provide an up-to-date comprehensive review of the industrial perspective at the interface of biomaterials and drugs. General concepts related to regulatory affairs or such as cost-conscious planning of manufacturing processes will be covered by interactive case-studies and in close interaction between students and lecturers. The course covers the future at the biomaterial-implant interface - as it is seen by the industry today - and will be reviewed by experienced and long-standing faculty from industry with the aim to provide a balanced, insightful perspective. From that, clinical development concepts, regulatory pathways and real-life case studies will be discussed with the students. Finally the students - working in small groups of 4-5 - will outline a development pathway for an industrial project and present it to the course and in presence of all faculty to receive maximum feedback to their approaches.

The student will become familiar with the major elements required for a successful development and which challenges have to be taken into account to translate an idea into a successful product.

Projects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-1210-00L</td>
<td>Project I</td>
<td>O</td>
<td>12</td>
<td>26A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Independent scientific practice of 6 weeks which is completed with a written report.</td>
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<tr>
<td>Objective</td>
<td>Projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.</td>
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<tr>
<td>327-1211-00L</td>
<td>Project II</td>
<td>O</td>
<td>12</td>
<td>26A</td>
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<tr>
<td>Abstract</td>
<td>Independent scientific practice of 6 weeks which is completed with a written report.</td>
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<tr>
<td>Objective</td>
<td>Projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.</td>
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Master Thesis

<table>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>327-9000-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Independent scientific work of current topics in the field of materials science. Duration 6 months. The work is documented in a written form.</td>
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<tr>
<td>Objective</td>
<td>Master thesis is a six month fulltime project and will encourage the students to work independently and in a structured and scientific way. It is is guided by a professor of the Department of Materials.</td>
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</tbody>
</table>

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATL.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses

ETH/UZH

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>327-0401-AAL</td>
<td>Materials Science II</td>
<td>E-</td>
<td>3</td>
<td>6R</td>
<td>A. D. Schlüter, J. Kübler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Physical properties and fracture mechanics of brittle materials.</td>
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</tr>
<tr>
<td>Content</td>
<td>The composition and microstructures of the most important ceramic materials are introduced. Microstructures and heterogenous phase equilibria and the properties of the four most important structural ceramics and glass are given. An introduction to fracture mechanics of brittle materials will allow to predict the survival probabilities and life time of components under static and dynamic load.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>For ceramics see: <a href="http://www.complex.mat.ethz.ch/education/lectures.html">http://www.complex.mat.ethz.ch/education/lectures.html</a></td>
<td></td>
<td></td>
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Basic Principles of Materials Physics A

**Abstract**
Foundations and applications of equilibrium thermodynamics and statistical mechanics, supplemented by an elementary theory of transport phenomena.

**Objective**
The course provides a solid working knowledge in thermodynamics (as the appropriate language for treating a variety of problems in materials science) and in statistical mechanics (as a systematic tool to find thermodynamic potentials for specific problems).

**Content**
- Thermodynamics, Statistical Mechanics
  1. Introduction
  2. Foundations of Thermodynamics
  3. Applications of Thermodynamics
  4. Foundations of Classical Statistical Mechanics
  5. Applications of Classical Statistical Mechanics
  6. Elementary Theory of Transport Phenomena

**Lecture notes**
Ein Leitfaden und ein zusammenfassender Artikel werden auf der oben angegebenen Website zur Lehrveranstaltung zur Verfügung gestellt.

**Literature**
- Modern Ceramic Engineering; David Richerson, Ed. 2, Dekker, 1992.
- P. Gambardella

Basic Principles of Materials Physics B

**Abstract**
This course introduces classical and quantum mechanical concepts for the understanding of material properties from a microscopic point of view. The lectures focus on the static and dynamic properties of crystals, the formation of chemical bonds and electronic bands in molecules, insulators, metals, and semiconductors, and on the thermal and electrical properties that emerge from this analysis.

**Objective**
Providing physical concepts for the understanding of materials properties.

**Content**
PART I: Structure of solid matter, real and reciprocal space
- The crystal lattice, Bravais lattices, primitive cells and unit cells, Wigner-Seitz cell, primitive lattice vectors, lattice with a basis, examples of 3D and 2D lattices.
- Fourier transforms and reciprocal space, reciprocal lattice vectors, Brillouin zones

PART II: Dynamics of atoms in crystals
- Lattice vibrations and phonons in 1D, phonons in 1D chains with monoatomic basis, phonon in 1D chains with a diatomic basis, optical and acoustic modes, phase and group velocities, phonon dispersion and eigenvectors. Phonons in 2D and 3D.
- Quantum mechanical description of lattice waves in solids, the harmonic oscillator, the concept of phonon, phonon statistics, Bose-Einstein distribution, phonon density of states, Debye and Einstein models, thermal energy, heat capacity of solids.

PART III: Electron states and energy bands in molecules and solids
- Introduction to molecular orbital theory and linear combination of atomic orbitals (LCAO). The H2+ molecule, homonuclear and heteronuclear molecules, benzene, sigma and pi bonds, sp3 and sp2 hybridization. From molecules to periodic crystal structures.
- The free electron gas: Fermi statistics, Fermi energy and Fermi surface, density of states in k-space and as a function of energy. Inadequacy of the free electron model.

PART IV: Electrical and heat conduction
- Dynamics of electrons in energy bands, phase and group velocity, crystal momentum, the effective mass concept, scattering phenomena. The equilibrium and non-equilibrium distribution function for electrons, the Boltzmann equation in the presence of external fields in the relaxation time approximation.
- Electrical and thermal conductivities revisited. Electron transport due to electric fields (drift) and concentration gradients (diffusion). Einstein’s relations. Transport of heat by electrons, Seebeck effect and thermopower, Peltier effect, thermoelectric cooling, thermoelectric energy conversion.

PART V: Semiconductors: concepts and devices
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Required</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>327-0506-AAL</td>
<td>Materials Physics</td>
<td>2</td>
<td>E-</td>
<td>P. Gambardella</td>
</tr>
<tr>
<td>327-0503-AAL</td>
<td>Ceramics I</td>
<td>3</td>
<td>E-</td>
<td>M. Niederberger, T. Graule, A. R. Studart</td>
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<tr>
<td>327-0603-AAL</td>
<td>Ceramics II</td>
<td>3</td>
<td>E-</td>
<td>A. R. Studart, K. Conder</td>
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<tr>
<td>327-0502-AAL</td>
<td>Polymers I</td>
<td>3</td>
<td>E-</td>
<td>M. Kröger</td>
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<tr>
<td>327-0606-AAL</td>
<td>Polymers II</td>
<td>3</td>
<td>E-</td>
<td>P. Smith, T.B. Schweizer</td>
</tr>
</tbody>
</table>

**Literature**
- H. Ibach, H. Lüth: Solid-State Physics (Springer: 2003), available as eBook from the ETH library, also in German.
- C. Kittel, Introduction to Solid State Physics (Wiley, 2005), also available in German.

**Prerequisites / notice**
The lecture will be given in English. The script will be available in English.
Abstract
Principles of polymer technology

Objective
To obtain an understanding of the engineering aspects of structure and properties of solid polymers. Influence of polymer processing on properties of solid polymers.

Content
1. Crystallization of semi-crystalline polymers
2. Glass transition of amorphous polymers
3. Mechanical properties of solid polymers
4. Examples of polymer processing
5. Laboratory exercises

Lecture notes
http://www.polytech.mat.ethz.ch/education/courses/PolymerenII

Literature
W. Kaiser, Kunststoffchemie für Ingenieure (Hanser, München, 2005)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites</th>
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<tr>
<td>327-0501-AAL</td>
<td>Metals I</td>
<td>E-3</td>
<td>6R</td>
<td>R. Spolenak</td>
</tr>
<tr>
<td>327-0612-AAL</td>
<td>Metals II</td>
<td>E-3</td>
<td>6R</td>
<td>R. Spolenak, M. Diener</td>
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<tr>
<td>327-0610-AAL</td>
<td>Advanced Composites</td>
<td>E-3</td>
<td>6R</td>
<td>F. J. Clemens, A. Winistorfer</td>
</tr>
</tbody>
</table>
Abstract
Introduction of basic concepts for composites with polymer-, metal- and ceramic matrix composites; production and properties of composites reinforced with particles, whiskers, short and long fibres; selection criteria, case histories of applications, recycling, future perspectives, and basic concepts for adaptive and functional composites

Objective
Gain an insight into the diversity of opportunities to change the properties of composites, learn about the most important applications and processing techniques

Content
1. Introduction
1.1 What are advanced composites?
1.2 What are materials by combination?
1.3 Are composites an idea of today?
1.4 Delphi foresight
1.5 Why composites?
1.6 References for chapter 1

2. Basic modules
2.1 Particles
2.2 Short fibres including whiskers
2.3 Long fibres
2.4 Matrix materials
2.4.1 Polymers
2.4.2 Metals
2.4.3 Ceramics and glasses
2.5 References for chapter 2

3. PMC: Polymer Matrix Composites
3.1 Historical background
3.2 Types of PMC-laminates
3.3 Production, processing and machining operation
3.4 Mechanics of reinforcement, microstructure, interfaces
3.5 Failure criteria
3.6 Fatigue behaviour of a multiply composite
3.7 Adaptive materials systems
3.8 References for chapter 3

4. MMC: Metal matrix composites
4.1 Introduction: Definitions, selection criteria und "design"
4.2 Types von MMCs - examples und typical properties
4.3 Mechanical and physical properties of MMCs - basics of design, influencing variables and damage mechanisms
4.4 Production processes
4.5 Microstructure / interfaces
4.6 Machining operations for MMC
4.7 Applications
4.8 References for chapter 4

5. CMC: Ceramic Matrix Composites
5.1 Introduction and historical background
5.2 Modes of reinforcement
5.3 Production processes
5.4 Mechanisms of reinforcement
5.5 Microstructure / interfaces
5.6 Properties
5.7 Applications
5.8 Materials testing and quality assurance
5.9 References for chapter 5

Lecture notes
The script will be delivered at the begin of the semester

Literature
The script is including a comprehensive list of references

Prerequisites / notice
Before each class, students will get a handout. Students will get the power point presentation of each class by e-mail.
The exercises take place in small groups. It is their goal to deepen knowledge gained in the classes
written end of semester examination

Materials Science Master - Key for Type

<table>
<thead>
<tr>
<th></th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

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

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.

### Mathematics (General Courses)

#### Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education Subject didactics for mathematics and computer science teachers.</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz</td>
</tr>
</tbody>
</table>

**Abstract**

Didactics colloquium

### Major in Insurance Mathematics

Further pieces of information are available at Prof. P. Embrechts's secretariat, HG F42.

### Economics and Business Administration

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0711-00L</td>
<td>Accounting for Managers Overview of financial and managerial accounting</td>
<td>E-</td>
<td>3</td>
<td>2V</td>
<td>J.P. Chardonnens</td>
</tr>
</tbody>
</table>

**Abstract**

Overview of financial and managerial accounting
- Accounting for current and fixed assets
- Liabilities and owners equity
- Recording change in balance sheet
- Measuring financial performance
- Managing financial reporting
- Full and variable costing system
- Using accounting information for decision making purposes
- Record change in financial position
- Measure business income
- Prepare final accounts
- Understand the principles of cost accounting
- Calculate the different product costs
- Make decisions about the acceptance or rejection of a particular product

**Objective**

Understand the different procedures involved in the accounting system

**Content**

Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,

Managerial Accounting: Full costing, variable costing, cost-volume profit, break-even analysis, activity-based costing

**Prerequisites / notice**

This course is a prerequisite for the course Financial Management.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-3611-00L</td>
<td>Advanced Topics in Computational Statistics</td>
<td>Z</td>
<td>4</td>
<td>2V</td>
<td>M. H. Maathuis, M. Mächler</td>
</tr>
</tbody>
</table>

**Abstract**

This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

**Objective**

Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

**Content**

The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

**Lecture notes**

Lecture notes.

**Prerequisites / notice**

We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-3627-00L</td>
<td>High-Dimensional Statistics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>P. L. Bühlmann</td>
</tr>
</tbody>
</table>

**Abstract**

“High-Dimensional Statistics” deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation algorithms for complex models and aspects of multiple testing will be discussed.

**Objective**

Knowledge of methods and basic theory for high-dimensional statistical inference

**Content**

Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

**Literature**


**Prerequisites / notice**

Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

### Principles of Law and Practical Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0703-00L</td>
<td>Introduction to Law Students who have attended or will attend the lecture &quot;Introduction to Law for Civil Engineering and Architecture&quot; or &quot;Introduction to Law&quot; (851-0708-00) cannot register for this course unit.</td>
<td>E-</td>
<td>2</td>
<td>2V</td>
<td>O. Streiff Gnöpff</td>
</tr>
</tbody>
</table>

**Abstract**

This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

**Objective**

Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.
Content
Basic concepts of law, sources of law.
Private law: Contract law (particularly contract for work and services), tort law, property law.
Public law: Human rights, administrative law, procurement law, procedural law.
Insights into the law of the EU and into criminal law.

Lecture notes
Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library)

Literature
Further documents will be available online (see https://moodle-app2.lot.ethz.ch/course/view.php?id=1596).

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<th>Mathematics (General Courses) - Key for Type</th>
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<tr>
<td>W+</td>
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<tr>
<td>W</td>
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<td>E-</td>
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<td>Z</td>
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<td>Dr</td>
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<th>Key for Hours</th>
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<tbody>
<tr>
<td>V</td>
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<table>
<thead>
<tr>
<th>ECTS</th>
<th>European Credit Transfer and Accumulation System</th>
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<tbody>
<tr>
<td></td>
<td>Special students and auditors need special permission from the lecturers.</td>
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# First Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-1261-07L</td>
<td>Analysis I</td>
<td>O</td>
<td>10</td>
<td>6V+3U</td>
<td>H. Knörrer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The ability to work with the basics of calculus in a mathematically rigorous way.</td>
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<tr>
<td></td>
<td>R. Courant: Introduction to Calculus and Analysis, Springer Verlag</td>
<td></td>
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<tr>
<td></td>
<td>V. Zorich: Mathematical Analysis I, Springer Verlag 2009</td>
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<tr>
<td></td>
<td>H. Heuser: Lehrbuch der Analysis, Teubner Verlag</td>
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<td></td>
<td>W. Walter: Analysis I, Springer Verlag</td>
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<td></td>
<td>O. Forster: Analysis I, Vieweg Verlag</td>
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<td></td>
<td>J. Appell: Analysis in Beispielen und Gegenbeispielen, Springer Verlag <a href="http://www.springerlink.com/content/q67803/?p=091fa376aade4cb8b2b2145fe2cee40&amp;pi=4">http://www.springerlink.com/content/q67803/?p=091fa376aade4cb8b2b2145fe2cee40&amp;pi=4</a></td>
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<tr>
<td>401-1151-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>E. Kowalski</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the theory of vector spaces for mathematicians and physicists including solutions of linear equations, linear transformations, determinants, eigenvalues and eigenvectors, bilinear forms, canonical forms for matrices, and selected applications, part I.</td>
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<tr>
<td>Objective</td>
<td>Mastering basic concepts of Linear Algebra</td>
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<tr>
<td>402-1701-00L</td>
<td>Physics I</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>G. Dissertori</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.</td>
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<tr>
<td>Objective</td>
<td>Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.</td>
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<tr>
<td>252-0847-00L</td>
<td>Computer Science</td>
<td>O</td>
<td>5</td>
<td>2V+2U</td>
<td>B. Gärtner</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
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<tr>
<td>Objective</td>
<td>The goal of this lecture is an algorithmically oriented introduction to programming.</td>
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</tr>
<tr>
<td>Content</td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Lecture notes in English and Handouts in German will be distributed electronically along with the course.</td>
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</table>

## Compulsory Courses

### Examination Block I

In Examination Block I either the course unit 402-2883-00L Physics III or the course unit 402-2203-01L Classical Mechanics must be chosen and registered for an examination. (Students may also enrol for the other of the two course units; within the ETH Bachelor Programme Mathematics, this other course unit cannot be registered for an examination. Knowledge of classical mechanics is presupposed in the spring semester core course 402-0224-00L Theoretical Physics.)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-2303-00L</td>
<td>Complex Analysis</td>
<td>O</td>
<td>6</td>
<td>3V+2U</td>
<td>R. Pandharipande</td>
</tr>
<tr>
<td>Abstract</td>
<td>Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, special functions, conformal mappings, Riemann mapping theorem.</td>
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<tr>
<td>Objective</td>
<td>Working Knowledge with functions of one complex variables; in particular applications of the residue theorem</td>
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</tr>
<tr>
<td>Literature</td>
<td>Th. Gamelin: Complex Analysis, Springer 2001</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>E. Titchmarsh: The Theory of Functions, Oxford University Press</td>
<td></td>
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<td></td>
<td>D. Salamon: &quot;Funktionentheorie&quot;, Birkhauser, 2011. (In German)</td>
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<td></td>
<td>R. Remmert: Theory of Complex Functions. Springer Verlag</td>
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</tbody>
</table>
Core Courses
Core Courses: Pure Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3531-00L</td>
<td>Differential Geometry I</td>
<td>W</td>
<td>10</td>
<td>4V+1U</td>
<td>M. Burger</td>
</tr>
</tbody>
</table>

Abstract
This course is an introduction to differential and riemannian geometry.

Objective
The aim is to lead students from a reasonable knowledge of advanced calculus, basic knowledge of general topology and solid knowledge of linear algebra to fundamental knowledge of differentiable manifolds and their basic tools. Riemannian geometry, some basic Lie theory, and de Rham cohomology will be developed as applications.

Literature
W. Boothby “An introduction to differentiable manifolds and Riemannian geometry”
J.M. Lee “Introduction to smooth manifolds”
M.P. Do Carmo “Riemannian Geometry”
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Schedule</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3461-00L</td>
<td>Functional Analysis I</td>
<td>10</td>
<td>4V+1U</td>
<td>D. A. Salomon</td>
</tr>
<tr>
<td>401-3371-00L</td>
<td>Dynamical Systems I</td>
<td>10</td>
<td>4V+1U</td>
<td>W. Merry</td>
</tr>
<tr>
<td>401-3118-09L</td>
<td>Modular Forms</td>
<td>8</td>
<td>3V+1U</td>
<td>Ö. Imamoglu</td>
</tr>
<tr>
<td>401-3001-61L</td>
<td>Algebraic Topology I</td>
<td>8</td>
<td>4G</td>
<td>P. Biran</td>
</tr>
<tr>
<td>401-3132-00L</td>
<td>Commutative Algebra</td>
<td>10</td>
<td>4V+1U</td>
<td>P. D. Nelson</td>
</tr>
</tbody>
</table>

**Functional Analysis I**
- **Abstract**: Baire category; Banach and Hilbert spaces, bounded linear operators; Three Fundamental Principles: Uniform Boundedness, Open Mapping/Closed Graph, Hahn-Banach; Convexity; Dual Spaces: weak and weak* topologies, Banach-Alaoglu, reflexive spaces; Ergodic Theorem; compact operators and Fredholm theory, Closed Image Theorem; Spectral theory, self-adjoint operators.
- **Lecture notes**: Lecture Notes on “Functional Analysis” by D.A. Salamon

**Dynamical Systems I**
- **Abstract**: This course is a Part I of a broad introduction to dynamical systems. Topic covered include topological dynamics, symbolic dynamics, ergodic theory, hyperbolic dynamics. In Part II (FS 2016), we will cover low-dimensional dynamics, complex dynamics, measure-theoretic entropy and Hamiltonian dynamics.
- **Objective**: Mastery of the basic methods and principal themes of dynamical systems.
- **Content**: The course introduces the principal themes of modern dynamical systems. Topics covered include:
  1. Topological dynamics (transitivity, attractors, chaos, structural stability)
  2. Symbolic dynamics (Perron-Frobenius theorem, zeta functions)
  3. Ergodic theory (Poincare recurrence theorem, Birkhoff ergodic theorem, existence of invariant measures)
  4. Hyperbolic dynamics (Grobman-Hartman theorem, Shadowing lemma, Closing lemma and applications)
- **Literature**: The most relevant textbook for this course is Introduction to Dynamical Systems, Brin and Stuck, CUP, 2002.
  Another excellent book (which will be relevant also for Dynamical Systems II) is Lectures on Dynamical Systems, Zehnder, EMS 2010.
  A more advanced textbook which covers everything in both Dynamical Systems I and II (and much more!) is Introduction to the Modern Theory of Dynamical Systems, Katok and Hasselblatt, CUP, 1995.
- **Prerequisites / notice**: The material of the basic courses of the first two years of the program at ETH is assumed. Some basic differential geometry and functional analysis would be useful but not essential.

**Modular Forms**
- **Abstract**: This is an introductory course on automorphic forms covering its basic properties with emphasis on connections with number theory.
- **Objective**: The aim of the course is to cover the classical theory of modular forms.
- **Content**: Basic definitions and properties of SL(2,Z), its subgroups and modular forms for SL(2,Z). Eisenstein and Poincare series. L-functions of modular forms, Hecke operators. Theta functions. Possibly Maass forms. Possibly automorphic forms for more general groups.
- **Literature**: J.P. Serre, A Course in Arithmetic; N. Koblitz, Introduction to Elliptic Curves and Modular Forms; D. Zagier, The 1-2-3 of Modular Forms; H. Iwaniec, Topics in Classical Automorphic Forms.
- **Prerequisites / notice**: The material of the basic courses of the first two years of the program at ETH is assumed. Some basic differential geometry and functional analysis would be useful but not essential.

**Algebraic Topology I**
- **Abstract**: This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory, homology and cohomology of spaces.
  Book can be downloaded for free at: http://www.math.cornell.edu/~hatcher/AT/ATpage.html  
  See also: http://www.math.cornell.edu/~hatcher/#anchor1772800  
  3) E. Spanier, "Algebraic topology", Springer-Verlag  
  General topology, linear algebra.
- **Prerequisites / notice**: Some knowledge of differential geometry and differential topology is useful but not absolutely necessary.

**Commutative Algebra**
- **Abstract**: This course is meant to provide an introduction to commutative algebra that equips the student to start studying the basics of algebraic geometry.
- **Objective**: About the course: We shall closely follow the text "Introduction to Commutative Algebra" by M. F. Atiyah and I. G. Macdonald. Wherever possible, there will be extra focus on exercises that lead towards the basics of Algebraic Geometry. Topics include
  * Basics about rings, ideals and modules  
  * Localisation  
  * Primary decomposition  
  * Integral dependence and valuations  
  * Noetherian rings  
  * Completions  
  * Basic dimension theory
- **Literature**: 1. "Introduction to Commutative Algebra" by M. F. Atiyah and I. G. Macdonald (Addison-Wesley Publ., 1969)  
- **Prerequisites / notice**: General topology, linear algebra.

Core Courses: Pure Mathematics (Mathematics Master)
Core Courses: Applied Mathematics and Further Appl.-Oriented Fields

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3651-00L</td>
<td>Numerical Methods for Elliptic and Parabolic Partial Differential Equations</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>C. Schwab</td>
</tr>
<tr>
<td></td>
<td>Course audience at ETH: 3rd year ETH BSc Mathematics and MSc Mathematics and MSc Applied Mathematics students. Other ETH-students are advised to attend the course &quot;Numerical Methods for Partial Differential Equations&quot; (401-0674-00L) in the CSE curriculum during the spring semester.</td>
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<td></td>
<td>Abstract</td>
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<td>This course gives a comprehensive introduction into the numerical treatment of linear and non-linear elliptic boundary value problems, related eigenvalue problems and linear, parabolic evolution problems. Emphasis is on theory and the foundations of numerical methods. Practical exercises include MATLAB implementations of finite element methods.</td>
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<td>Objective</td>
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</table>
|              | Participants of the course should become familiar with 
|              |   * concepts underlying the discretization of elliptic and parabolic boundary value problems 
|              |   * analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems 
|              |   * methods for the efficient solution of discrete boundary value problems 
|              |   * implementation aspects of the finite element method |      |      |       |                 |
|              | Content                                         |      |      |       |                 |
|              | A selection of the following topics will be covered: |      |      |       |                 |
|              | * Elliptic boundary value problems |      |      |       |                 |
|              | * Galerkin discretization of linear variational problems |      |      |       |                 |
|              | * The primal finite element method |      |      |       |                 |
|              | * Mixed finite element methods |      |      |       |                 |
|              | * Discontinuous Galerkin Methods |      |      |       |                 |
|              | * Boundary element methods |      |      |       |                 |
|              | * Spectral methods |      |      |       |                 |
|              | * Adaptive finite element schemes |      |      |       |                 |
|              | * Singularly perturbed problems |      |      |       |                 |
|              | * Sparse grids |      |      |       |                 |
|              | * Galerkin discretization of elliptic eigenproblems |      |      |       |                 |
|              | * Non-linear elliptic boundary value problems |      |      |       |                 |
|              | * Discretization of parabolic initial boundary value problems |      |      |       |                 |
|              | Lecture notes                                   |      |      |       |                 |
|              | Course slides will be made available to the audience. |      |      |       |                 |
|              | Literature                                      |      |      |       |                 |
|              | n.a.                                            |      |      |       |                 |
|              | Prerequisites / notice                          |      |      |       |                 |
|              | Practical exercises based on MATLAB             |      |      |       |                 |
|              | Core Courses: Applied Mathematics and Further Appl.-Oriented Fields (Mathematics Master) |      |      |       |                 |

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<th>Number</th>
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<tr>
<td>401-3601-00L</td>
<td>Probability Theory</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>A.S. Sznitman</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Basics of probability theory and the theory of stochastic processes in discrete time</td>
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<td></td>
<td>Objective</td>
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<td>This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<td>Lecture notes</td>
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<td>available, will be sold in the course</td>
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<td></td>
<td>H. Bauer, Probability Theory, de Gruyter 1996</td>
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<td></td>
<td>J. Jacod and P. Protter, Probability essentials, Springer 2004</td>
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<td></td>
<td>A. Klenke, Wahrscheinlichkeitstheorie, Springer 2006</td>
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<td></td>
<td>D. Williams, Probability with martingales, Cambridge University Press 1991</td>
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<th>Lecturers</th>
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<tr>
<td>401-3621-00L</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>S. van de Geer</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>The course covers the basics of inferential statistics.</td>
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<thead>
<tr>
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<th>Type</th>
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<tr>
<td>252-0057-00L</td>
<td>Theoretical Computer Science</td>
<td>W</td>
<td>8 credits</td>
<td>4V+2U+1A</td>
<td>J. Hromkovic, E. Welzl</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Concepts to cope with: a) what can be accomplished in a fully automated fashion (algorithmically solvable) b) How to measure the inherent difficulty of tasks (problems) c) What is randomness and how can it be useful? d) What is nondeterminism and what role does it play in CS? e) How to represent infinite objects by finite automata and grammars?</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>Learning the basic concepts of computer science along their historical development</td>
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<td></td>
<td>Content</td>
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<td>This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems. The main topics of the lecture are: - alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks - finite automata, regular and context-free grammars - Turing machines and computability - complexity theory and NP-completeness - design of algorithms for hard problems</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<tr>
<td></td>
<td>The lecture is covered in detail by the textbook &quot;Theoretical Computer Science&quot;.</td>
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### Electives

#### Selection: Algebra, Topology, Discrete Mathematics, Logic

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>8</td>
<td>4V+1U</td>
<td>E. Welzl, T. Holenstein, A. Steger</td>
</tr>
<tr>
<td>401-3035-00L</td>
<td>Forcing: An Introduction to Independence Proofs</td>
<td>W</td>
<td>8</td>
<td>3V+1U</td>
<td>L. Halbeisen</td>
</tr>
<tr>
<td>401-3109-65L</td>
<td>Probabilistic Number Theory</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>E. Kowalski</td>
</tr>
<tr>
<td>401-3202-09L</td>
<td>Representation Theory of Finite Groups, and in</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>A. Buryak</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>Literature</th>
</tr>
</thead>
</table>

### Prerequisites / notice

- Voraussetzung ist die Vorlesung "Axiomatische Mengenlehre" (Fruehlingssemester 2015) bzw. die entsprechenden Kapitel aus meinem Buch.

- Further reading:

- More exercises and examples in:
  6. A. Athero, Ch. Baier: Theoretische Informatik

- During the semester, two non-obligatory test exams will be offered.

- Introduction to Algorithms by T. H. Cormen, C. E. Leiserson, R. L. Rivest;

- Randomized Algorithms by R. Motwani und P. Raghavan;


- Voraussetzung ist die Vorlesung "Axiomatische Mengenlehre" (Fruehlingssemester 2015) bzw. die entsprechenden Kapitel aus meinem Buch.

- Prerequisites:
  - Complex analysis, measure and integral; some probability theory is useful but the main concepts needed will be recalled.
  - Some knowledge of number theory is useful but the main results will be summarized.

### Selection: Geometry

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>8</td>
<td>4V+1U</td>
<td>E. Welzl, T. Holenstein, A. Steger</td>
</tr>
<tr>
<td>401-3035-00L</td>
<td>Forcing: An Introduction to Independence Proofs</td>
<td>W</td>
<td>8</td>
<td>3V+1U</td>
<td>L. Halbeisen</td>
</tr>
<tr>
<td>401-3109-65L</td>
<td>Probabilistic Number Theory</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>E. Kowalski</td>
</tr>
<tr>
<td>401-3202-09L</td>
<td>Representation Theory of Finite Groups, and in</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>A. Buryak</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J.-P. Serre. Linear Representations of Finite Groups.</td>
</tr>
<tr>
<td></td>
<td>It will be assumed that the listeners know the material from a basic linear algebra course and also basic facts about groups and rings.</td>
</tr>
</tbody>
</table>

- More exercises and examples in:
  6. A. Athero, Ch. Baier: Theoretische Informatik

- During the semester, two non-obligatory test exams will be offered.

- Introduction to Algorithms by T. H. Cormen, C. E. Leiserson, R. L. Rivest;

- Randomized Algorithms by R. Motwani and P. Raghavan;


- Voraussetzung ist die Vorlesung "Axiomatische Mengenlehre" (Fruehlingssemester 2015) bzw. die entsprechenden Kapitel aus meinem Buch.

- Prerequisites:
  - Complex analysis, measure and integral; some probability theory is useful but the main concepts needed will be recalled.
  - Some knowledge of number theory is useful but the main results will be summarized.

### Prerequisites / notice

- Voraussetzung ist die Vorlesung "Axiomatische Mengenlehre" (Fruehlingssemester 2015) bzw. die entsprechenden Kapitel aus meinem Buch.

- Prerequisites:
  - Complex analysis, measure and integral; some probability theory is useful but the main concepts needed will be recalled.
  - Some knowledge of number theory is useful but the main results will be summarized.
A polygon in the plane can be decomposed into finitely many (convex) pieces and reassembled to form another polygon if and only if they have the same area. Hilbert's third problem asks if the analogous is also true for two polyhedra in space. Whether or not it is possible to define volume without the use of approximation arguments depends on the answer to this question.

The course will cover classical results on equidecomposability including the Dehn-Sydler theorem, i.e. the solution to Hilbert's third problem. We will then describe the connection between equidecomposability and valuation theory. Finally, we will discuss some recent classification results of valuations that are invariant under certain groups of motions.

Office hours: Thursday 11:00 - 12:00

Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with classical theories of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Möbius planes, error correcting codes, block design

- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.

**Selection: Analysis**

- no course offer

**Selection: Numerical Analysis**

- no course offer

**Selection: Probability Theory, Statistics**

- no course offer
Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Lecture notes
A script will be available.

Literature

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

401-0625-01L Applied Analysis of Variance and Experimental Design

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

Abstract
Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content

Lecture notes
see website

Literature

Selection: Financial and Insurance Mathematics

In the Bachelor's programme in Mathematics 401-3913-01L Mathematical Foundations for Finance is eligible as an elective course, but only if 401-3888-00L Introduction to Mathematical Finance isn't recognised for credits (neither in the Bachelor's nor in the Master's programme). For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-4905-06L</td>
<td>Interest Rate Theory</td>
<td>W</td>
<td>8 credits</td>
<td>3V+1U</td>
<td>not available</td>
</tr>
</tbody>
</table>

Abstract
We introduce and discuss the most important models for interest rate markets. Emphasis will be placed both on theoretical foundations and on numerical implementation and calibration.

Objective
- Gain overview of interest rate markets and the corresponding financial products.
- Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
- Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.
- Learn about extensions that have recently become increasingly important: default risk, multiple yield curves, etc.
- Gain overview of interest rate markets and the corresponding financial products.
- Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
- Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.
- Learn about extensions that have recently become increasingly important: default risk, multiple yield curves, etc.

Literature

Prerequisites / notice
- Linear algebra.
- Itô calculus.

401-3953-00L Interest Rate Modeling in Discrete Time

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3953-00L</td>
<td>Interest Rate Modeling in Discrete Time</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>M. V. Wüthrich</td>
</tr>
</tbody>
</table>

Abstract
This course gives an introduction to stochastic interest rate modeling in discrete time. Starting from cash flow valuation with state price deflators, we derive the equivalent martingale measures for pricing financial instruments and derivatives of primary assets. The lecture is supplemented by several examples such as the Vasicek model where we also study model calibration.

Objective
The students are familiar with the basic terminology of stochastic interest rate modeling and he is able to transfer his (financial) mathematical knowledge to real world pricing of cash flows and financial instruments.

Content
The following topics are covered:
1) stochastic discounting with state price deflators
2) equivalent martingale measures
3) pricing of cash flows and primary assets
4) pricing of derivatives, e.g. European put options
5) (multi-factor) Vasicek state price deflator model
6) Heath-Jarrow-Morton interest rate modeling framework

One might have, more provocatively, entitled the course: How does time end (in, Einstein’s general relativity)? In a word, badly. Not in a

The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and

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The following topics are treated:

- Chaotically Singular Spacetimes
- General Relativity

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The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and
Algorithmic Game Theory

Abstract
Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.

Objective
Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.

Literature
Suggested textbooks:
C. Misner, K. Thorne and J. Wheeler: Gravitation
S. Carroll: Spacetime and Geometry: An Introduction to General Relativity
R. Wald - General Relativity
S. Weinberg - Gravitation and Cosmology
N. Straumann - General Relativity with applications to Astrophysics

Randomized Algorithms and Probabilistic Methods

The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so that they can use these concepts in the computational and algorithmic setting.

Abstract
Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)

Objective
The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains.

Content
Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), Delaunay triangulations and the art gallery theorem, convexity in Rd, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone theorem, Hyperplane-sandwich cuts), 3-SUM hardness, counting planar triangulations.

Lecturers
B. Gärtner

Outlook: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

Algorithmic Game Theory

Abstract
Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.

Objective
Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.

Content
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and a selfish equilibrium.
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks.

Prerequisites / notice
Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

Randomized Algorithms and Probabilistic Methods

Abstract
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshhev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content
Randomized Algorithms are algorithms that "flip coins" to make decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecturers
Yes.
Complexity Theory classifies problems according to the resources required in order to solve them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, NP, AM, PH, PSPACE, IP, EXP), and study circuit complexity.

Objective
The student learns the fundamentals of Complexity Theory, as well as some of the more recent techniques. He not only understands the basic results and techniques used to prove them, but also has insight in some of the technically more advanced theorems.

Content
Complexity Theory classifies problems according to the difficulty of solving them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, PSPACE, IP, EXP), and study the known relationship to uniform complexity. We study circuit complexity, and its relationship to uniform complexity. We also will study some circuit lower bounds for constant depth circuits, as well as results which explain why it is difficult to improve these results.

Select: Further Realms

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3502-65L</td>
<td>Reading Course <em>THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.</em></td>
<td>W</td>
<td>2</td>
<td>4A</td>
<td>Professors</td>
</tr>
<tr>
<td>401-3503-65L</td>
<td>Reading Course <em>THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.</em></td>
<td>W</td>
<td>3</td>
<td>6A</td>
<td>Professors</td>
</tr>
<tr>
<td>401-3504-65L</td>
<td>Reading Course <em>THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.</em></td>
<td>W</td>
<td>4</td>
<td>9A</td>
<td>Professors</td>
</tr>
<tr>
<td>227-0445-00L</td>
<td>Advanced Mathematical Signal Processing <em>Block course: Starts on October 8 and ends on November 26, 2015 Thursdays 10-12 and 13-16</em></td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>H. G. Feichtinger</td>
</tr>
</tbody>
</table>

Abstract
The student learns the fundamentals of Complexity Theory, as well as some of the more recent techniques. He not only understands the basic results and techniques used to prove them, but also has insight in some of the technically more advanced theorems.

Content
Complexity Theory classifies problems according to the difficulty of solving them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, PSPACE, IP, EXP), and study the known relationship to uniform complexity. We study circuit complexity, and its relationship to uniform complexity. We also will study some circuit lower bounds for constant depth circuits, as well as results which explain why it is difficult to improve these results.

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

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Abstract
Usually Fourier Analysis and Systems Theory emphasize the analogy between the different settings (continuous&discrete, periodic&non-periodic). The author proposes a simple approach to generalized functions, based on a Banach space of test functions. The course provides the foundations to Banach Gelfand triples, but also concrete applications in signal processing (time-variant systems, sampling).

Objective
Deeper mathematical understanding of the foundations of signal processing and system theory. The setting of Banach Gelfand Triples allows to provide a framework that allows among others to discuss the relations between different settings (e.g. the generalized Fourier transform of functions on the Euclidean space and corresponding FFT-based routines).
Time-Frequency Analysis and its discretized version, namely Gabor Analysis have required to develop a family of function spaces (the so-called modulation spaces, introduced by Feichtinger in the 80th) which is different from the usual Lebesgue spaces. There is a smallest space (called $S_0$) and a largest space (namely the dual space), which is a suitable reservoir of generalized functions relevant for the rigorous establishment of basic results in signal processing (sampling theorem, Poisson formula, Fourier inversion, etc.). The course will be centered about the basic properties of the Banach Gelfand triple $(S_0,L^2,S_0')$ (also called rigged Hilbert space), its use for signal processing and systems theory applications. In addition to classical questions we will also discuss the fundamental results of time-frequency analysis (Short-time Fourier transform, Gabor frames, Gabor multipliers, best approximation of operators by Gabor multipliers, identification of slowly varying channels using pilote tones, etc.).

There will be a script related to the course. In fact, material for a book project on the subject is developed while the course is given. We will not need background on Lebesgue integration or topological vector spaces (as usually required for the treatment of distributions).

### Core Courses and Electives (Mathematics Master)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-1511-00L</td>
<td>Geometry</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>L. Halbeisen</td>
</tr>
</tbody>
</table>

**Abstract**

Im Mittelpunkt dieser Vorlesung steht die euklidische und die projektive Geometrie.

**Objective**


**Content**


**Literature**

Robin Hartshorne: “Geometry: Euclid and beyond”, Springer Verlag

Eric Lort: “Symmetry and Pattern in Projective Geometry”, Springer Verlag

### Minor Courses

#### Core Courses (Mathematics Master)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0351-00L</td>
<td>Astronomy</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>H. M. Schmid, W. Schmutz</td>
</tr>
</tbody>
</table>

**Abstract**

An overview on the important topics in modern astronomy: planets, sun, stars, milky way, galaxies, and cosmology

**Objective**

This lecture gives a general introduction to main topics in modern astronomy. The lecture provide a basis for the more advanced lectures in astrophysics.

**Content**

Planet en, Sonne, Sterne, Milchstrasse, Galaxien und Kosmologie.

**Lecture notes**

Kopien der Präsentationen werden zur Verfügung gestellt.

**Literature**

Astronomie. Harry Nussbaumer, Hans Martin Schmid

vdf Vorlesungsakripte (8. Auflage)

Der Neue Kosmos. A. Unsöld, B. Baschek, Springer

### Seminars

Early enrolments for seminars in myStudies are encouraged, so that we will recognize need for additional seminars in a timely manner. Some seminars have waiting lists. Nevertheless, register for at most two mathematics seminars. In this case, you express a stronger preference for the seminar for which you register earlier.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3050-65L</td>
<td>Student Seminar in Combinatorics: Linear Complementarity</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>K. Fukuda</td>
</tr>
</tbody>
</table>

**Abstract**

Number of participants limited to 18.

**Objective**

We study the combinatorics and the complexity of various subclasses of the linear complementarity problem.

**Content**

The Linear Complementarity Problem (LCP) was introduced in mid 1960's (1965-67) by Lemke and Cottle-Dantzig as a common generalization of linear programming, bimatrix games and convex quadratic programming.

The problem is NP-hard in general, but there are many subclasses of LCP that are in P (polynomially solvable) or suspected to be in P. The reason for the possible polynomially solvability is that these studied subclasses (e.g. P-matrix LCPs and positive-definite LCPs) can be formulated as a problem which admits a solution that has a succinct certificate for its correctness. Moreover, there are elegant combinatorial abstractions of these subclasses.

In this seminar, we study the most important papers/books, both old and new, in the theory of LCP, and aim at understanding what is crucial lack of knowledge in proving or disproving existing conjectures.

**Literature**

To be posted here before the first class on September 15.

The seminar schedule and a list of articles:


Accepted Reports:


The slides of the overview (Revised on September 22, 2015):


**Prerequisites**

Basic knowledge of linear programming.

### Autumn Semester 2015

In this seminar, we study the most important papers/books, both old and new, in the theory of LCP, and aim at understanding what is crucial lack of knowledge in proving or disproving existing conjectures.

**Literature**

To be posted here before the first class on September 15.

The seminar schedule and a list of articles:


Accepted Reports:


The slides of the overview (Revised on September 22, 2015):


**Prerequisites**

Basic knowledge of linear programming.
### 401-3600-65L Regularity Structures
- **Number of participants**: 15 up to 20.
- **Abstract**: The seminar introduces and discusses main theorems around Martin Hairer's regularity structures following the article "Introduction to regularity structures" (Braz Jour Prob Stat 29).
- **Prerequisites / notice**: The seminar is suited for Bachelor and Master students. Some knowledge in linear functional analysis and algebra is required.
- **Number**: 4 credits
- **Semester**: 2S
- **Lecturers**: J. Teichmann

### 401-3650-65L Numerical Analysis Seminar: Mathematics for Nanophotonics
- **Limited number of participants.**
- **Abstract**: Study and presentation of research papers from the literature on "Boolean Satisfiability-Combinatorics and Algorithms". An emphasis will be put on analyzing plasmon resonant nanoparticles.
- **Prerequisites / notice**: Algebra I and II. Some familiarity with modular forms and Lie algebras is helpful, but not crucial: all necessary concepts will be introduced in the early talks.
- **Objective**: To understand the equation 196884 = 196883 + 1.
- **Number of participants limited to**: 16.
- **Content**: see https://www2.math.ethz.ch/education/bachelor/seminars/hs2015/monstrous-moonshine/monshine_overview
- **Semester**: 2S
- **Lecturers**: C. A. Keller

### 401-3110-65L Monstrous Moonshine
- **Abstract**: We study Monstrous Moonshine, the surprising connection between modular forms and the Monster group.
- **Objective**: To understand the equation 196884 = 196883 + 1.
- **Prerequisites / notice**: Algebra I and II. Some familiarity with modular forms and Lie algebras is helpful, but not crucial: all necessary concepts will be introduced in the early talks.
- **Number**: 4 credits
- **Semester**: 2S
- **Lecturers**: H. Ammari

### 263-4200-00L Seminar SAT
- **Objective**: Study and presentation of research papers from the literature on "Boolean Satisfiability-Combinatorics and Algorithms".
- **Literature**: A list of papers for presentations will be distributed at the beginning of the seminar.
- **Prerequisites / notice**: The seminar builds heavily on the material covered in the course "Boolean Satisfiability-Combinators and Algorithms." Successful completion of that course is a prerequisite for participation in the seminar.
- **Number of participants limited to**: 16.
- **Number**: 2 credits
- **Semester**: 2S
- **Lecturers**: E. Welzl

### 263-4203-00L Geometry: Combinatorics and Algorithms
- **Abstract**: This seminar is held once a year and complements the courses Computational Geometry and Geometric Graphs: Combinatorics & Algorithms. Students of the seminar will present original research papers, some classic and some of them very recent. The seminar is a good preparation for a master, diploma, or semester thesis in the area.
- **Objective**: Each student is expected to read, understand, and elaborate on a selected research paper. To this end, (s)he should give a 45-min. presentation about the paper. The process includes:
  * getting an overview of the related literature;
  * understanding and working out the background/motivation: why and where are the questions addressed relevant?
  * understanding the contents of the paper in all details;
  * selecting parts suitable for the presentation;
  * presenting the selected parts in such a way that an audience can follow;
  * understanding and working out the background/motivation: why and where are the questions addressed relevant?
- **Prerequisites / notice**: To attend the seminar, some basic knowledge in (discrete and computational) geometry and graphs and algorithms is required. Thus, previous participation in some of the courses "Graphs and Algorithms", "Computational Geometry", "Geometric Graphs: Combinators & Algorithms", or similar courses is strongly encouraged. It is also possible to take this seminar in parallel to the course "Computational Geometry".
- **Number of participants limited to**: 16.
- **Number**: 2 credits
- **Semester**: 2S
- **Lecturers**: B. Gärtner, E. Welzl

### Bachelor Thesis

#### Bachelor Thesis (Mathematics Master)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

The seminar builds heavily on the material covered in the course "Boolean Satisfiability-Combinatorics and Algorithms." Successful completion of that course is a prerequisite for participation in the seminar.

* Target audience:
  - Third year Bachelor students;
  - Master students who cannot document to have received an adequate training in working scientifically.

* Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later.
* Optional for Bachelor and Master students with matriculation until or before the spring semester 2014.
* Example: You matriculated in the autumn semester 2013 into the first semester of the Bachelor programme, are now in the third year and plan to matriculate in the autumn semester 2016 into the first semester of the Master programme. In this case, you don't need "Scientific Works in Mathematics" in order to complete the Bachelor degree, but for the Master degree you will need it. In this case, we recommend that you register for "Scientific Works in Mathematics" in the autumn semester 2015 or spring semester 2016.

* Directive

* Abstract
  Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

* Objective
  Learn the basic standards of scientific works in mathematics.

* Content
  - Types of mathematical works
  - Publication standards in pure and applied mathematics
  - Data handling
  - Ethical issues
  - Citation guidelines
Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-3990-10L Bachelor's Thesis
No direct enrolment to this course unit in myStudies. Please fill in the online application form.
Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html
(Afterwards the enrolment will be done by the Study Administration.)
Abstract
The purpose of the BSc thesis is to deepen knowledge in a certain subject chosen by the student. In their BSc thesis, students should demonstrate their ability to carry out independent work in mathematics and to organize results in a written report.

Prerequisites / notice
Occasionally, talks may be delivered in German.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATH.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>W. Werner, P. L. Bühlmann,</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>M. Burger, S. Mishra,</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>P. L. Bühlmann,</td>
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<td></td>
<td></td>
<td></td>
<td>M. Burger, S. Mishra,</td>
</tr>
<tr>
<td>401-5990-00L</td>
<td>Zurich Graduate Colloquium</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>A. Iozzi, University lecturers</td>
</tr>
<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>N. Hungerbühler, M. Akveld,</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>J. Hromkovic, K. Klemenz</td>
</tr>
<tr>
<td>251-0100-00L</td>
<td>Computer Science Colloquium</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>Lecturers</td>
</tr>
<tr>
<td>401-9931-00L</td>
<td>Foundations of Mathematics</td>
<td>E-</td>
<td>4</td>
<td>2V+1A</td>
<td>L. Halbeisen</td>
</tr>
</tbody>
</table>

Objective
The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.

Content
Eingeladene Vorträge aus dem gesamten Bereich der Informatik, zu denen auch Auswärige kostenlos eingeladen sind. Zu Semesterbeginn erscheint jeweils ein ausführliches Programm.
Abstract
Das Ziel dieser Vorlesung ist die Vermittlung der grundlegenden Konzepte und Begriffe der Mathematik. Dazu gehören die Sprache der Mathematik (d.h. Aussagenlogik und Prädikatenlogik), Modelle von Axiomensystemen (inkl. Gödelscher Vollständigkeitssatz), Beweismethoden, der Aufbau der Zahlen von den natürlichen Zahlen bis zu den reellen Zahlen, sowie die Axiome der Mengenlehre.

Objective
Das Ziel dieser Vorlesung ist die Vermittlung der grundlegenden Konzepte und Begriffe der Mathematik. Dazu gehören die Sprache der Mathematik (d.h. Aussagenlogik und Prädikatenlogik), Modelle von Axiomensystemen (inkl. Gödelscher Vollständigkeitssatz), Beweismethoden, der Aufbau der Zahlen von den natürlichen Zahlen bis zu den reellen Zahlen, sowie die Axiome der Mengenlehre (auf denen die gesamte Mathematik aufgebaut ist).
Die Vorlesung ist mit Übungen. Über das Semester verteilt finden 8 Übungsstunden statt.

Literature
Als ergänzende Literatur zur Vorlesung kann ich folgende beiden Bücher empfehlen:

<table>
<thead>
<tr>
<th>Mathematics Bachelor - Key for Type</th>
<th>O</th>
<th>W+</th>
<th>W</th>
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<tr>
<td>Compulsory</td>
<td>E-</td>
<td>Z</td>
<td>Dr</td>
</tr>
<tr>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td></td>
</tr>
<tr>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
<td></td>
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<tr>
<th>Key for Hours</th>
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<tr>
<td>lecture</td>
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<tr>
<td>lecture with exercise</td>
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<tr>
<td>exercise</td>
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<tr>
<td>seminar</td>
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<tr>
<td>colloquium</td>
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<table>
<thead>
<tr>
<th>ECTS</th>
<th>European Credit Transfer and Accumulation System</th>
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<tr>
<td></td>
<td>Special students and auditors need special permission from the lecturers.</td>
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</table>
### Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<td>Enrolment only possible with matriculation in Teaching</td>
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<td></td>
<td>Diploma or Teaching Certificate (excluding Teaching</td>
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<td></td>
<td>Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful</td>
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<tr>
<td></td>
<td>participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
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</tr>
<tr>
<td></td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<tr>
<td></td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner,</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching</td>
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<td></td>
<td>B. Rütsche</td>
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<td></td>
<td>Diploma or Teaching Certificate (excluding Teaching</td>
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<td></td>
<td>Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful</td>
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<tr>
<td></td>
<td>participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td></td>
<td>- Getting to know intelligence tests</td>
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</tr>
<tr>
<td></td>
<td>- Understanding findings relevant for education</td>
<td></td>
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</tr>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche,</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching</td>
<td></td>
<td></td>
<td></td>
<td>E. Stern, E. Ziegler</td>
</tr>
<tr>
<td></td>
<td>Diploma or Teaching Certificate (excluding Teaching</td>
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<td></td>
<td>Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful</td>
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<tr>
<td></td>
<td>participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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</tr>
<tr>
<td></td>
<td>Abstract</td>
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</tr>
<tr>
<td></td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<tr>
<td></td>
<td>Objective</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<tr>
<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<tr>
<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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</tr>
</tbody>
</table>

**Subject Didactics and Professional Training**

Important: You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

Enrolment in either Mathematics Didactics I or Mathematics Didactics II (spring semester) is compulsory.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3971-11L</td>
<td>Mathematics Didactics I</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>K. Barro</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Mathematics Teaching Diploma or Mathematics TC at ETH or in Mathematics Teaching Diploma at UZH.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching various topics in mathematics. Methodological suggestions are compared and draft tuition concepts discussed.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating learning arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.</td>
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</tr>
<tr>
<td>401-9987-00L</td>
<td>Teaching Internship Including Examination Lessons</td>
<td>O</td>
<td>4</td>
<td>9P</td>
<td>N. Hungerbüchner</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Enrolment only possible with matriculation in Teaching</td>
<td></td>
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<tr>
<td></td>
<td>Diploma Mathematics for TC and Teaching Diploma Mathematics as Minor Subject.</td>
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<tr>
<td>Abstract</td>
<td>Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.</td>
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</tr>
</tbody>
</table>
Finite Geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Möbius planes, error correcting codes, block design.

Objective

- The objective is for the students:
  - to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
  - to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Abstract

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Content

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen


Literatur

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Prerequisites / notice

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Specialized Courses in Respective Subject with Educational Focus

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Finite Geometries II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-0293-00L</td>
<td>Mathematics III</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>E. W. Farkas</td>
</tr>
</tbody>
</table>

Objective

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Abstract

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Content

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen


Literatur

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Prerequisites / notice

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Specialized Courses in Respective Subject with Educational Focus

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3057-00L</td>
<td>Finite Geometries II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-0293-00L</td>
<td>Mathematics III</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>E. W. Farkas</td>
</tr>
</tbody>
</table>

Objective

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Abstract

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Content

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen


Literatur

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Prerequisites / notice

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Specialized Courses in Respective Subject with Educational Focus

<table>
<thead>
<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>401-3057-00L</td>
<td>Finite Geometries II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-0293-00L</td>
<td>Mathematics III</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>E. W. Farkas</td>
</tr>
</tbody>
</table>
Die Studierenden kennen die wesentlichen Elemente der mathematischen Modellierung. Sie sind in der Lage, Modelle zu erstellen und mathematisch zu diskutieren. Sie können selbstständig Unterrichtssequenzen zur Modellierung entwickeln.

**Literatur**


**Prerequisites / notice**

Vorlesungen Mathematik III

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0931-00L</td>
<td>Foundations of Mathematics</td>
<td>4 credits</td>
<td>2V+1A</td>
<td>L. Halbeisen</td>
</tr>
<tr>
<td>401-9985-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Mathematics A</td>
<td>2 credits</td>
<td>4A</td>
<td>M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler</td>
</tr>
</tbody>
</table>

**Course Details**

- **Content**
  - Modellbildung
  - Lineare Modelle
  - Vektorräume, Normalformen.
  - Lösungsraum eines Linearen DGL-Systems
  - Qualitative Aussagen, Nichtlineare Modelle: Stabilität für eine DGL 1. Ordnung, für allgemeine DGL-Systeme
  - Modelle in Raum und Zeit: Partielle DGL, Fourier-Reihe, -Transformation, Laplace-Operator

- **Literature**

- **Prerequisites / notice**
  - Grundvorlesungen zur Analysis

- **Course Code** 401-0931-00L
  - **Course Title**: Foundations of Mathematics
  - **Credits**: 4
  - **ECTS**: 2V+1A
  - **Instructor**: L. Halbeisen

- **Course Code** 401-9985-00L
  - **Course Title**: Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Mathematics A
  - **Credits**: 2
  - **ECTS**: 4A
  - **Instructor**: M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler

**Notice**

Die Vorlesung ist mit Übungen. Über das Semester verteilt finden 8 Übungsstunden statt.

**Data:** 06.12.2018 13:04  Autumn Semester 2015  Page 1031 of 1432
Eine Anleitung zur mentorierten Arbeit in FV wird zur Verfügung gestellt.
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

### Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education</td>
<td>E-</td>
<td>0 credits</td>
<td></td>
<td>N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz</td>
</tr>
</tbody>
</table>

**Abstract**

Didactics colloquium

---

### Mathematics TC - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
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</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

### Notice

Special students and auditors need special permission from the lecturers.
Mathematics Teaching Diploma

The programme “Teaching Diploma, Two Subjects in One-Step Procedure” will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

► Mathematics as First Subject

★★ Educational Science

Course offerings in the category Educational Science are listed under “Programme: Educational Science for Teaching Diploma and TC”.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td></td>
<td>Abstract: This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<tr>
<td></td>
<td>Objective: - Get to know cognitively activating instructions in MINT subjects - Get information about recent literature on learning and instruction</td>
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<tr>
<td></td>
<td>Prerequisites / notice: Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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</tr>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td></td>
<td>Abstract: The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td></td>
<td>Objective: - Understanding of research methods used in the empirical human sciences - Getting to know intelligence tests - Understanding findings relevant for education</td>
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</tr>
<tr>
<td></td>
<td>Prerequisites / notice: This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td></td>
<td>Abstract: Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<tr>
<td></td>
<td>Objective: - Understand research methods used in the empirical educational sciences - Understand and critically examine information from scientific journals and media - Understand pedagogically relevant findings from the empirical educational sciences</td>
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<tr>
<td></td>
<td>Number of participants limited to 20.</td>
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<td></td>
<td>The successful completion of both course no. 851-0240-00L “Menschliches Lernen (EW 1)” and course no. 851-0239-01L “Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)” is a necessary prerequisite for this course.</td>
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<tr>
<td></td>
<td>Abstract: In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<td></td>
<td>Objective: The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)</td>
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<td></td>
<td>Learning goals include: - Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples. - Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction. - Participants can design and conduct a study that is relevant for answering their research question. - Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.</td>
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</tbody>
</table>
Subject Didactics in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3971-11L</td>
<td>Mathematics Didactics I</td>
<td>O</td>
<td>4</td>
<td>2G</td>
<td>K. Barro</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Mathematics Teaching Diploma or Mathematics TC at ETH or in Mathematics Teaching Diploma at ZiZH.</td>
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<tr>
<td></td>
<td>Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching various topics in mathematics. Methodological suggestions are compared and draft tuition concepts discussed.</td>
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<tr>
<td></td>
<td>On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating teaching arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.</td>
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<tr>
<td>401-9983-00L</td>
<td>Mentored Work Subject Didactics Mathematics A</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Mentored Work Subject Didactics in Mathematics for TC, Teaching Diploma and Teaching Diploma Mathematics as Minor Subject.</td>
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<td></td>
<td>In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.</td>
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<tr>
<td></td>
<td>The objective is for the students:</td>
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<tr>
<td></td>
<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
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<tr>
<td></td>
<td>- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Thematische Schwerpunkte</td>
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<td></td>
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<tr>
<td></td>
<td>Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.</td>
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<tr>
<td></td>
<td>Lernformen</td>
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<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.</td>
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<tr>
<td></td>
<td>Literature</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.</td>
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</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
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</tr>
<tr>
<td></td>
<td>Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.</td>
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</tr>
<tr>
<td>401-9984-00L</td>
<td>Mentored Work Subject Didactics Mathematics B</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Mentored Work Subject Didactics in Mathematics for Teaching Diploma, Teaching Diploma Mathematics as Minor Subject and for students upgrading TC to Teaching Diploma.</td>
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<tr>
<td></td>
<td>In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.</td>
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<tr>
<td></td>
<td>The objective is for the students:</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
<td></td>
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<tr>
<td></td>
<td>- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.</td>
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<tr>
<td></td>
<td>Content</td>
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</tr>
<tr>
<td></td>
<td>Thematische Schwerpunkte</td>
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</tr>
<tr>
<td></td>
<td>Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.</td>
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<tr>
<td></td>
<td>Lernformen</td>
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<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.</td>
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</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.</td>
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</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.</td>
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</tbody>
</table>

Professional Training in Mathematics

Professional Training (First Subject)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9970-00L</td>
<td>Introductory Internship Mathematics</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Mathematics Teaching Diploma or Mathematics TC at ETH. It is advisable to enrol in this course not prior to the first Mathematics Didactics course and not after the second Mathematics Didactics course.</td>
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<td></td>
<td>During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.</td>
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</tbody>
</table>
Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen

Teaching Internship Mathematics II

This is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the

Examination Lesson I Mathematics

On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating learning arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.

Prerequisites / notice

This course is to be chosen jointly with 401-3972-00L.

401-9988-00L

Teaching Internship Mathematics I - for students upgrading to Teaching Diploma Mathematics as Major Subject

Enrolment only possible with matriculation in Mathematics Teaching Diploma or Mathematics TC at ETH. Simultaneous enrolment in Mathematics Didactics - course unit 401-3971-11L - is compulsory.

Abstract

Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching mathematics. Methodological suggestions are compared and draft tuition concepts discussed.

Objective

On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating learning arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.

Prerequisites / notice

Findet in der Regel am Schluss der Ausbildung, vor Ablegung der Prüfungslektionen statt.

401-9989-00L

Teaching Internship Mathematics II - for students upgrading to Teaching Diploma

Abstract

This is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.

Objective

Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen

and beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel zu lernen (Fach-)Wissen zu erwerben.

Content


401-9991-00L

Examination Lesson I Mathematics - Simultaneous enrolment in "Examination Lesson II Mathematics" (401-9991-02L) is compulsory.

Abstract

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter and didactic skills they have acquired in the course of their training.

Objective

On the basis of a specified topic, the candidate shows that they are in a position to:

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content


Die gehaltene Lektion wird kritiernsbares gestaltet. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/ der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

Literature

Wird von der Praktikumslehrperson bestimmt.
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

The programme "Teaching Diploma, Two Subjects in One-Step Procedure" will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.
Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Objective
Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

Content
- To develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- To analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Abstract
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter and didactic skills they have acquired in the course of their training.

Literature
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.

Prerequisites / notice
Nach Abschluss der übrigen Ausbildung.

Teaching Diploma in 2 Subjects in One-Step Procedure: no courses from this category have to be completed.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-3057-00L</td>
<td>Finite Geometries II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-0293-00L</td>
<td>Mathematics III</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>E. W. Farkas</td>
</tr>
<tr>
<td>401-0293-99L</td>
<td>Mathematics III (Supplement)</td>
<td>W</td>
<td>1</td>
<td>1A</td>
<td>N. Hungerbühler</td>
</tr>
</tbody>
</table>

Objective
Vertiefung und Ausbau des Stoffes Mathematik III für die Anwendung in der Systemanalyse.

Content
- Modellbildung
- Lineare Modelle:
  - Vektorräume, Normalformen,
  - Lösungsraum eines Linearen DGL-Systems
- Qualitative Aussagen, Nichtlineare Modelle:
  - Stabilität für eine DGL 1. Ordnung, für allgemeine DGL-Systeme
  - Modelle in Raum und Zeit
  - Partielle DGL, Fourier-Reihe, Transformation, Laplace-Operator
- Vorlesungen Mathematik III

Abstract
Simultaneous enrolment in "Mathematics III" (401-0293-00L) is compulsory.

Objective
Die Studierenden kennen die wesentlichen Elemente der mathematischen Modellierung. Sie sind in der Lage, Modelle zu erstellen und mathematisch zu diskutieren. Sie können selbständig Unterrichtsssequenzen zur Modellierung entwickeln.
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective

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

Content


Lecture notes

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

Literature

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

401-9986-00L Mentored Work Specialised Courses in the Respective O Subject with an Educational Focus Mathematics

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-9986-00L</td>
<td>Mentored Work Specialised Courses in the Respective O Subject with an Educational Focus Mathematics</td>
<td>2 credits</td>
<td>4A</td>
<td>M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler</td>
<td></td>
</tr>
</tbody>
</table>

Abstract

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

Objective

Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

Grundvorlesungen zur Analysis

Grundvorlesung zur Analysis

Literature


Prerequisites / notice

Grundvorlesungen zur Analysis

Literature

Als ergänzende Literatur zur Vorlesung kann ich folgende beiden Bücher empfehlen:


401-9985-00L Mentored Work Specialised Courses in the Respective O Subject with an Educational Focus Mathematics

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9985-00L</td>
<td>Mentored Work Specialised Courses in the Respective O Subject with an Educational Focus Mathematics</td>
<td>2 credits</td>
<td>4A</td>
<td>M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler</td>
<td></td>
</tr>
</tbody>
</table>

Abstract

Das Ziel dieser Vorlesung ist die Vermittlung der grundlegenden Konzepte und Begriffe der Mathematik. Dazu gehören die Sprache der Mathematik (d.h. Aussagenlogik und Prädikatenlogik), Modelle von Axiomensystemen (inkl. Gödel'scher Vollständigkeitssatz), Beweismethoden, der Aufbau der Zahlen von den natürlichen Zahlen bis zu den reellen Zahlen, sowie die Axiome der Mengenlehre.

Objective

Das Ziel dieser Vorlesung ist die Vermittlung der grundlegenden Konzepte und Begriffe der Mathematik. Dazu gehören die Sprache der Mathematik (d.h. Aussagenlogik und Prädikatenlogik), Modelle von Axiomensystemen (inkl. Gödel'scher Vollständigkeitssatz), Beweismethoden, der Aufbau der Zahlen von den natürlichen Zahlen bis zu den reellen Zahlen, sowie die Axiome der Mengenlehre (auf denen die gesamte Mathematik aufgebaut ist).

Die Vorlesung ist mit Übungen. Über das Semester verteilt finden 8 Übungsstunden statt.

Content


Lecture notes

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

Literature

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

401-9931-00L Foundations of Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9931-00L</td>
<td>Foundations of Mathematics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1A</td>
<td>L. Halbeisen</td>
</tr>
</tbody>
</table>

Abstract

Das Ziel dieser Vorlesung ist die Vermittlung der grundlegenden Konzepte und Begriffe der Mathematik. Dazu gehören die Sprache der Mathematik (d.h. Aussagenlogik und Prädikatenlogik), Modelle von Axiomensystemen (inkl. Gödel'scher Vollständigkeitssatz), Beweismethoden, der Aufbau der Zahlen von den natürlichen Zahlen bis zu den reellen Zahlen, sowie die Axiome der Mengenlehre.

Objective

Das Ziel dieser Vorlesung ist die Vermittlung der grundlegenden Konzepte und Begriffe der Mathematik. Dazu gehören die Sprache der Mathematik (d.h. Aussagenlogik und Prädikatenlogik), Modelle von Axiomensystemen (inkl. Gödel'scher Vollständigkeitssatz), Beweismethoden, der Aufbau der Zahlen von den natürlichen Zahlen bis zu den reellen Zahlen, sowie die Axiome der Mengenlehre (auf denen die gesamte Mathematik aufgebaut ist).

Die Vorlesung ist mit Übungen. Über das Semester verteilt finden 8 Übungsstunden statt.

Content


Lecture notes

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

Literature

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

401-9986-00L Mentored Work Specialised Courses in the Respective O Subject with an Educational Focus Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9986-00L</td>
<td>Mentored Work Specialised Courses in the Respective O Subject with an Educational Focus Mathematics</td>
<td>2 credits</td>
<td>4A</td>
<td>M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler</td>
<td></td>
</tr>
</tbody>
</table>

Abstract

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

Objective

The aim is for the students

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

Content


Lecture notes

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

Literature

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.
Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsdie's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.

401-3057-00L Finite Geometries II

Abstract
Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Objective
Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

Content
Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Moebius planes, error correcting codes, block design

Literature
- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.

401-9951-58L Didactics of Mathematics at the College Level I

(University of Zurich)

Enrolment only possible with matriculation in Teaching Diploma or TC at ETH or in Teaching Diploma at UZH.

Abstract
Students are familiarised with the subjects taught at high-school level I (the first three years of the full-length high school, or the first year of the reduced-length high school). The central contents of geometry, arithmetic and algebra, and also written mathematical problems are explained.

Objective
In the teaching given at high-school level I (the first three years of the full-length high school or the first year of the reduced-length high school), central concepts and approaches adopted in mathematics are introduced and observed in greater depth. These include variables, function, proof. This calls for a careful didactic analysis on the part of the teacher, requiring them to study and reflect on the prerequisites for the pupils and the requirements in terms of mathematics and cognitive psychology.

Content
Beispiele von Schülerarbeiten geben in diesem Seminar einen Einblick in die mathematische Denkwelt der Schülerinnen und Schüler. Vielfältige Aufgaben zum Einsatz im Unterricht werden vorgestellt, selber gelöst und diskutiert.

Literature
- Arithmetik und Algebra: Zahlbereiche, Form und Inhalt in der Algebra.
- Geometrie: Konstruieren-Berechnen-Beweisen, dynamische Geometrie (Geogebra).
- Sachrechnen: Funktionsbegriff, mathematische Modellierung.
- Aktuelle matheamtkididaktische Aspekte wie Lernprozesse, Grundvorstellungen, Kompetenzen, offene Aufgaben.

Prerequisites / notice
Seminar mit Übungen

401-9931-00L Foundations of Mathematics

Abstract
Das Ziel dieser Vorlesung ist die Vermittlung der grundlegenden Konzepte und Begriffe der Mathematik. Dazu gehören die Sprache der Mathematik (d.h. Aussagenlogik und Prädikatenlogik), Modelle von Axiomensystemen (inkl. Gödel'scher Vollständigkeitssatz), Beweismethoden, der Aufbau der Zahlen von den natürlichen Zahlen bis zu den reellen Zahlen, sowie die Axiome der Mengenlehre.

Objective
Das Ziel dieser Vorlesung ist die Vermittlung der grundlegenden Konzepte und Begriffe der Mathematik. Dazu gehören die Sprache der Mathematik (d.h. Aussagenlogik und Prädikatenlogik), Modelle von Axiomensystemen (inkl. Gödel'scher Vollständigkeitssatz), Beweismethoden, der Aufbau der Zahlen von den natürlichen Zahlen bis zu den reellen Zahlen, sowie die Axiome der Mengenlehre (auf denen die gesamte Mathematik aufgebaut ist).

Literature
Als ergänzende Literatur zur Vorlesung kann ich folgende beiden Bücher empfehlen:

252-0855-00L Computer Science in Secondary School Mathematics

Abstract
The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.
Objective

The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

Content

The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

The course covers the didactics of logic, of cryptography, of finite state automata, of computability and of the introduction to programming. The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lecture notes

Literature


see Compulsory Elective Courses Teaching Diploma

Mathematics as Second Subject

Subject Didactics in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>
| 401-3971-11L | Mathematics Didactics I  
Enrolment only possible with matriculation in Mathematics  
Teaching Diploma or Mathematics TC at ETH or in Mathematics Teaching Diploma at UZH. | O    |  4   |  2G   | K. Barro                   |

Abstract

Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching various topics in mathematics. Methodological suggestions are compared and draft tuition concepts discussed.

Objective

On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating learning arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.

Content

Thematische Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen


Lecture notes

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Literature

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.
### Professional Training in Mathematics

<table>
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<tr>
<th>Number</th>
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<td>401-9987-00L</td>
<td>Teaching Internship Including Examination Lessons Mathematics B</td>
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<td>4</td>
<td>9P</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Teaching Internship Mathematics for TC and Teaching Diploma Mathematics as Minor Subject. Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.</td>
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</tbody>
</table>

#### Abstract

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are assessed as Examination Lessons. Whenever a teacher in charge of their teacher training, the students constantly evaluate their own performance. They learn to assess pupils’ work.

#### Objective

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle.
- They are able to develop a tuition sequence that is conducive to learning and teach 20 lessons independently. Two of them are assessed as Examination Lessons. Whenever a teacher in charge of their teacher training, the students constantly evaluate their own performance.
- They are able to develop a tuition sequence that is conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.
- They learn to assess pupils’ work.
- They are able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle.
- To be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle.
- To show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

#### Content

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

### Colloquia

<table>
<thead>
<tr>
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<th>Type</th>
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<th>Lecturers</th>
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<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education Subject didactics for mathematics and computer science teachers.</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>N. Hungerbühler, M. Akveld, J. Hronkovic, H. Klemenz</td>
</tr>
</tbody>
</table>

#### Abstract

Didactics colloquium

### Mathematics Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th></th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<td>Key for Hours</td>
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<td>--------------</td>
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<td></td>
<td></td>
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<tr>
<td>V</td>
<td>lecture</td>
<td></td>
<td></td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<td></td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS  European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Mathematics Master

Core Courses

For the Master's degree in Applied Mathematics the following additional condition (not manifest in myStudies) must be obeyed: At least 15 of the required 28 credits from core courses and electives must be acquired in areas of applied mathematics and further application-oriented fields.

Core Courses: Pure Mathematics

(Also Bachelor) core courses

(www.vvz.ethz.ch/Vorlesungsverzeichnis/sucheLehrangebot.do?seite=1&semkez=2015W&abschnittId=63461&lang=en&ansicht=1) are eligible under certain conditions.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<td>401-3225-00L</td>
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<td>W</td>
<td>8</td>
<td>4G+G</td>
<td>M. Einsiedler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Topological groups and Haar measure.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>A. Knapp: “Lie groups beyond an Introduction” (Birkhaeuser)</td>
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<td></td>
<td>Objective: The goal is to have a broad though foundational knowledge of the theory of Lie groups and their associated Lie algebras with an emphasis on the algebraic and topological aspects of it.</td>
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<tr>
<td>Literature</td>
<td>A. Knapp: “Lie groups beyond an Introduction” (Birkhaeuser)</td>
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<tr>
<td></td>
<td>A. Sagle &amp; R. Walde: “Introduction to Lie groups and Lie algebras” (Academic Press, ’73)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>F. Warner: “Foundations of differentiable manifolds and Lie groups” (Springer)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>H. Samelson: “Notes on Lie algebras” (Springer, ’90)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Topology and basic notions of measure theory. A basic understanding of the concepts of manifold, tangent space and vector field is useful, but could also be achieved throughout the semester.</td>
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<tr>
<td>Course webpage</td>
<td><a href="http://www.math.ethz.ch/education/bachelor/lectures/hs2014/math/introlg">http://www.math.ethz.ch/education/bachelor/lectures/hs2014/math/introlg</a></td>
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Core Courses: Applied Mathematics and Further Appl.-Oriented Fields

(Also Bachelor) core courses

(www.vvz.ethz.ch/Vorlesungsverzeichnis/sucheLehrangebot.do?seite=1&semkez=2015W&abschnittId=63462&lang=en&ansicht=1) are eligible under certain conditions.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>401-3118-09L</td>
<td>Modular Forms</td>
<td>W</td>
<td>8</td>
<td>3V+1U</td>
<td>Ö. Imamoglu</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is an introductory course on automorphic forms covering its basic properties with emphasis on connections with number theory.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The aim of the course is to cover the classical theory of modular forms.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>J.P. Serre, A Course in Arithmetic; N. Koblitz, Introduction to Elliptic Curves and Modular Forms; D. Zagier, The 1-2-3 of Modular Forms; H. Iwaniec, Topics in Classical Automorphic Forms.</td>
<td></td>
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<td>Prerequisites / notice</td>
<td>Course webpage: <a href="http://www.math.ethz.ch/education/bachelor/lectures/hs2014/math/introlg">http://www.math.ethz.ch/education/bachelor/lectures/hs2014/math/introlg</a></td>
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</table>

401-3651-00L Numerical Methods for Elliptic and Parabolic Partial Differential Equations

Course audience at ETH: 3rd year ETH BSc Mathematics and MSc Mathematics and MSc Applied Mathematics students.

Other ETH-students are advised to attend the course ‘Numerical Methods for Partial Differential Equations’ (401-0674-00L) in the CSE curriculum during the spring semester.

Abstract

This course gives a comprehensive introduction into the numerical treatment of linear and non-linear elliptic boundary value problems, related eigenvalue problems and linear, parabolic evolution problems. Emphasis is on theory and the foundations of numerical methods. Practical exercises include MATLAB implementations of finite element methods.

Objective

Participants of the course should become familiar with

- concepts underlying the discretization of elliptic and parabolic boundary value problems
- analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems
- methods for the efficient solution of discrete boundary value problems
- implementational aspects of the finite element method

Content

A selection of the following topics will be covered:

- Elliptic boundary value problems
- Galerkin discretization of linear variational problems
- The primal finite element method
- Mixed finite element methods
- Discontinuous Galerkin Methods
- Boundary element methods
- Spectral methods
- Adaptive finite element schemes
- Singularly perturbed problems
- Sparse grids
- Galerkin discretization of elliptic eigenproblems
- Non-linear elliptic boundary value problems
- Discretization of parabolic initial boundary value problems

Lecture notes

Course slides will be made available to the audience.

Literature

N. Koblitz, Introduction to Elliptic Curves and Modular Forms; H. Iwaniec, Topics in Classical Automorphic Forms.

401-3621-00L Fundamentals of Mathematical Statistics

The course covers the basics of inferential statistics.

Mathematical Optimization  

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>401-3901-00L</td>
<td>Mathematical Optimization</td>
<td></td>
<td>11 credits</td>
<td>4V+2U</td>
<td>R. Weismantel</td>
</tr>
</tbody>
</table>

Abstract: Mathematical treatment of diverse optimization techniques.

Objective: Advanced optimization theory and algorithms.

Content:
1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas’ Lemma and infeasibility certificates, duality theory of linear programming.
3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.
4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

(also Bachelor) Core Courses: Pure Mathematics

401-3531-00L Differential Geometry I can only be recognised for the Master Programme if 401-3532-00L Differential Geometry II has not been recognised for the Bachelor Programme. An analogously holds for:
401-3461-00L Functional Analysis I - 401-3462-00L Functional Analysis II
401-3001-61L Algebraic Topology I - 401-3002-12L Algebraic Topology II
401-3132-00L Commutative Algebra - 401-3146-12L Algebraic Geometry
401-3371-00L Dynamical Systems I - 401-3372-00L Dynamical Systems II

For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

Number | Title                          | Type | ECTS | Hours | Lecturers   |
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<tr>
<td>401-3531-00L</td>
<td>Differential Geometry I</td>
<td></td>
<td>10 credits</td>
<td>4V+1U</td>
<td>M. Burger</td>
</tr>
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</table>

Abstract: This course is an introduction to differential and riemannian geometry.

Objective: The aim is to lead students from a reasonable knowledge of advanced calculus, basic knowledge of general topology and solid knowledge of linear algebra to fundamental knowledge of differentiable manifolds and their basic tools. Riemannian geometry, some basic Lie theory, and de Rham cohomology will be developed as applications.

Literature: W.Boothby “An introduction to differentiable manifolds and Riemannian geometry”
J.M.Lee “Introduction to smooth manifolds”
M.P. Do Carmo “Riemannian Geometry”

401-3461-00L Functional Analysis I  

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<tr>
<th>Number</th>
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<td>401-3001-61L</td>
<td>Algebraic Topology I</td>
<td></td>
<td>8 credits</td>
<td>4G</td>
<td>P. Biran</td>
</tr>
</tbody>
</table>

Abstract: This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory, homology and cohomology of spaces.

Literature:

Book can be downloaded for free at: http://www.math.cornell.edu/~hatcher/AT/ATpage.html
See also: http://www.math.cornell.edu/~hatcher/#anchor1772800
3) E. Spanier, “Algebraic topology”, Springer-Verlag

Prerequisites / notice: General topology, linear algebra.

401-3371-00L Dynamical Systems I

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<tr>
<th>Number</th>
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<tr>
<td>401-3132-00L</td>
<td>Commutative Algebra</td>
<td></td>
<td>10 credits</td>
<td>4V+1U</td>
<td>P. D. Nelson</td>
</tr>
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</table>

Abstract: This course is meant to provide an introduction to commutative algebra that equips the student to start studying the basics of algebraic geometry.

Objective: About the course: We shall closely follow the text “Introduction to Commutative Algebra” by M. F. Atiyah and I. G. Macdonald. Wherever possible, there will be extra focus on exercises that lead towards the basics of Algebraic Geometry. Topics include:
* Basics about rings, ideals and modules
* Localization
* Primary decomposition
* Integral dependence and valuations
* Noetherian rings
* Completions
* Basic dimension theory

Literature:
References:

Prerequisites / notice: Prerequisites: Algebra I (or a similar introduction to the basic concepts of ring theory).

401-3371-00L Dynamical Systems I  

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>401-3371-00L</td>
<td>Dynamical Systems I</td>
<td></td>
<td>10 credits</td>
<td>4V+1U</td>
<td>W. Merry</td>
</tr>
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</table>

Abstract: This course is a Part I of a broad introduction to dynamical systems. Topic covered include topological dynamics, symbolic dynamics, ergodic theory, hyperbolic dynamics. In Part II (FS 2016), we will cover low-dimensional dynamics, complex dynamics, measure-theoretic entropy and Hamiltonian dynamics.

Objective: Mastery of the basic methods and principal themes of dynamical systems.
The course introduces the principal themes of modern dynamical systems. Topics covered include:

1. Topological dynamics
   (translivity, attractors, chaos, structural stability)

2. Symbolic dynamics
   (Perron-Frobenius theorem, zeta functions)

3. Ergodic theory
   (Poincaré recurrence theorem, Birkhoff ergodic theorem, existence of invariant measures)

4. Hyperbolic dynamics
   (Grobman-Hartman theorem, Shadowing lemma, Closing lemma and applications)

The most relevant textbook for this course is

Introduction to DYNAMICAL SYSTEMS, Brin and Stuck, CUP, 2002.

Another excellent book (which will be relevant also for Dynamical Systems II) is

Lectures on Dynamical Systems, Zehnder, EMS 2010.

A more advanced textbook which covers everything in both Dynamical Systems I and II (and much more) is


The material of the basic courses of the first two years of the program at ETH is assumed. Some basic differential geometry and functional analysis would be useful but not essential.

**ELECTIVES:**

For the Master's degree in Applied Mathematics the following additional condition (not manifest in myStudies) must be obeyed: At least 15 of the required 28 credits from core courses and electives must be acquired in areas of applied mathematics and further application-oriented fields.

**ELECTIVES: PURE MATHEMATICS**

**SELECTION:** Algebra, Topology, Discrete Mathematics, Logic

The course presents some aspects of probabilistic number theory, including distribution properties of the number of prime divisors of integers, probabilistic properties of the zeta function and statistical distribution of exponential sums.
The goal of the course is to present some results of probabilistic number theory in a unified manner. The main concepts will be presented in parallel with the proof of three main theorems: (1) the Erdős-Kac theorem and its variants concerning the number of prime divisors of integers in various sequences; (2) the distribution of values of the Riemann zeta function, including Selberg's central limit theorem for the Riemann zeta function on the critical line; (3) functional limit theorems for the paths of partial sums of families of exponential sums such as Kloosterman sums.

H. Iwaniec and E. Kowalski: "Analytic number theory", and additional lecture notes will be prepared.

Prerequisites / notice
Prerequisites: Complex analysis, measure and integral; some probability theory is useful but the main concepts needed will be recalled.
Some knowledge of number theory is useful but the main results will be summarized.

**Elliptic Curves**

---

**Combinatorics II**

**Objective**
The aim of this course is to get used to geometric objects and algebraic tools, such as elliptic curves, curves, heights and degree.

**Content**
Hours 4A ECTS 4

**Surfaces and 3-Manifolds**

---

**Geometric Invariant Theory (GIT)** is concerned with the problem of defining quotients of algebraic varieties by group actions, a crucial step in the construction of moduli spaces. Although some of the ideas go back to Hilbert, it was developed in its present form by Mumford in the 60s.

Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

**Literature**
J. Silverman "The arithmetic of Elliptic Curves"  J. Silverman " Advanced Topics in the arithmetic of Elliptic Curves" E. Bombieri & W. Gubler " Heights in Diophantine Geometry"

**Prerequisites / notice**
Algebra and Linear Algebra, Topology, Geometry, some basic Algebraic Geometry.

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**Combinatorics II**

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**Representation Theory of Finite Groups, and in Particular Symmetric Groups**

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**Reading Course: Geometric Invariant Theory**

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**Equidecomposability of Polytopes**

---

**Surfaces and 3-Manifolds**

---

**Selection: Geometry**

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**Number** 401-3149-65L 401-3059-00L 401-3202-09L 401-4149-65L 401-3523-65L 401-4573-65L

**Title** Elliptic Curves Combinatorics II Representation Theory of Finite Groups, and in Particular Symmetric Groups Reading Course: Geometric Invariant Theory Equidecomposability of Polytopes Surfaces and 3-Manifolds

**Type** W W W W W W

**ECTS** 4 4 4 2 4 4

**Hours** 2V 2G 2V 4A 2V 2V

**Lecturers** E. Viada N. Hungerbühler A. Buryak J. Fresán P. S. Jossen L. Parapatits

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**Data: 06.12.2018 13:04  Autumn Semester 2015  Page 1046 of 1432**
Objective
The goal is to give an overview of hyperbolic surfaces, Mapping Class Groups, construction of 3-manifolds, and the geometrisation theorem. The starting point will be the statement of the geometrisation theorem in dimension 2 and the goal the statement of the geometrisation theorem in dimension 3.

Prerequisites / notice
The choice of topics to discuss, especially in the second part of the course, can vary depending on the interests of the audience.

401-3057-00L

Finite Geometries I, II

Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Objective
Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

Content
Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Moebius planes, error correcting codes, block design.

Literature
- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries, Cambridge University Press
- Dembowski: Finite Geometries.

Selection: Analysis

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<tr>
<th>Number</th>
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<tr>
<td>401-4755-65L</td>
<td>Partial Differential Equations</td>
<td></td>
<td>7</td>
<td>4V</td>
<td>D. Christodoulou</td>
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</tbody>
</table>

Abstract
The course covers elliptic partial differential equations in connection to differential geometry and geometric elliptic variational problems. The main topics are the uniformization theorem for 2-dim Riemannian manifolds, harmonic maps from the unit disc to a n-dim Riemannian manifold, and the theory of parametric minimal surfaces in n-dim Euclidean space.

Prerequisites / notice
Prerequisites: Real Analysis and Differential Geometry

401-4589-63L

Calculus of Variations and Conformal Invariance

In this course we will present the classical theory as well as more recent developments of the calculus of variation of surfaces. We will expose method mixing functional analysis and differential geometry in order to produce and describe global and local minimizers or saddle points to two dimensional Lagrangians.

Content
In the first part of the course we will consider the area functional whose critical points are minimal surfaces and study the so called Plateau problem. Introduced originally by Lagrange in the 18th century. Then we will move to the systematic study of 2-dimensional conformally invariant Lagrangians and explain how they are all related to a generalized Plateau problem of prescribed mean curvature surfaces into submanifolds. In the last part of the course we will present a theory merging minimal surface theory and conformal invariance. This theory has been introduced in the early 20th century by Wilhelm Blaschke and is presently a very active field of research in geometric analysis due in particular to numerous applications in many fields of sciences such as general relativity, elasticity theory, cell biology etc.

Prerequisites / notice
Requirements:
Fundamental knowledge in functional analysis, Fourier analysis and differential geometry (FAI and DGI)

Selection: Further Realms

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<th>Number</th>
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<tr>
<td>401-3502-65L</td>
<td>Reading Course ■</td>
<td></td>
<td>2</td>
<td>4A</td>
<td>Professors</td>
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</table>

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

401-3503-65L

Reading Course ■

THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.

Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:
1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.
**Reading Course.**

**Abstract**

For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

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**401-3504-65L Reading Course**

THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.

Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:
1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

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**Electives: Applied Mathematics and Further Application-Oriented Fields**

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**Selection: Numerical Analysis**

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<tr>
<th>Number</th>
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<tr>
<td>401-4657-00L</td>
<td>Numerical Analysis of Stochastic Ordinary Differential Equations</td>
<td>W</td>
<td>6</td>
<td>3V+1U</td>
<td>A. Jentzen</td>
</tr>
</tbody>
</table>

**Abstract**

Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

**Objective**

The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

**Content**

- Generation of random numbers
- Monte Carlo methods for the numerical integration of random variables
- Stochastic ordinary differential equations (SODEs)
- Numerical approximations of SODEs
- Multilevel Monte Carlo methods for SODEs
- Applications to computational finance: Option valuation

**Lecture notes**

Lecture Notes will be available.

**Literature**


**Prerequisites / notice**

- Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.
  - a) mandatory courses: Elementary Probability, Probability Theory I.
  - b) recommended courses: Stochastic Processes.

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**401-4655-64L Numerical Analysis of High-Dimensional Problems for Uncertainty Quantification**

**Abstract**

In many applications of mathematics, efficient numerical methods for PDEs on high dimensional state and/or parameter spaces is required. This course provides succinct surveys of recently developed numerical methods, their computer implementation for model problems, and elements of their mathematical analysis for the efficient approximation of high- and infinite-dimensional PDE problems.
Content

1. Infinite-Dimensional Analysis
   Probability spaces and measures, Tensor Products, Measures on function spaces, Covariance operators, PCA and KL-expansions, (generalized) polynomial chaos expansions, Kolmogoroff N-widths

2. Examples
   Parametric Approximation Problems, Parametric ODEs (biochemical reaction pathways), Parametric PDEs (diffusion problems with random coefficients), PDEs in Parametric Domains (Scattering from random obstacles).


4. Stochastic Galerkin Methods

5. Stochastic Collocation Methods
   Smolyak’s algorithm and its generalizations; sparse, adaptive interpolation algorithms

6. Reduced Basis Methods

7. Monte Carlo Methods

8. Quasi-Monte Carlo Methods

9. Applications
   Bayesian Inverse Problems, Shape Sensitivity Analysis of PDEs, Optimal Control of parametric ODEs and PDEs, Optimization of Parametric ODEs and PDEs.

Literature

Books and Surveys:


2. F. Y. Kuo and Ch. Schwab and I. H. Sloan


4. Ch. Schwab and C. J. Gittelson

Prerequisites / notice

ETH BSc Math or equivalent

and

Num. elliptic and Parabolic PDE
or
Num. hyperbolic PDE

or

ETH Doctoral Studies in applied mathematics or CSE.

Programming:
MATLAB (for MSc MATH)
or
Python and C/C++/MPI programming (MSc CSE).

Selection: Probability Theory, Statistics

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<tr>
<th>Number</th>
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<tr>
<td>401-3591-65L</td>
<td>Introduction to Random Graphs</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>A. Knowles</td>
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<tr>
<td>401-4607-59L</td>
<td>Percolation Theory</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>P. Nolin</td>
</tr>
</tbody>
</table>

Abstract

This is an introductory course on random graphs, covering Erdos-Renyi graphs, inhomogeneous graphs, phase transition phenomena, connectivity, and random walks on random graphs.

Prerequisites / notice

A basic undergraduate course on probability.

Abstract

An introduction to the percolation theory.

Objective

The objective is to gain familiarity with the methods of the percolation theory and to learn some of its important results.

Content

Definition of percolation, FKG and BK inequalities, Harris-Kesten Theorem, Menshikov's Theorem, uniqueness of the infinite cluster and possibly Smirnov's Theorem on the conformal invariance of the critical percolation.
The course is roughly divided into three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and (3) handling missing data and graphical modeling. The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals. Time Series Analysis will be covered in detail, including spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R will be provided. The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R.

### Prerequisites

Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).
401-4607-65L Schramm-Loewner Evolution and Gaussian Free Field

Abstract
This block course taking place in January 2016 will be an introduction to the Schramm-Loewner Evolutions, which are random curves arising in a number of random planar systems.

Objective
Topics covered in this class will include:
- Definition of Loewner chains and their properties
- Definition and basic properties of Schramm-Loewner Evolutions
- Relation between SLE(4) and the Gaussian Free Field
- Survey of properties of some other SLE curves.

Prerequisites / notice
Students of the 2015-2016 Swissmap Master class program are welcome to attend.

The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and...
In this course we cover several fundamental equations of quantum physics: the Schrödinger equation, which lies at the foundation of quantum mechanics, and the general case of an arbitrary distribution of matter and gravitational field does not lead to the appearance of a singularity.

In 1963, Lifshitz and Khalatnikov constructed a class of singular solutions and concluded that '... the presence of a singularity in time is NOT a necessary property of cosmological models of the general theory of relativity, and that the general case of an arbitrary distribution of matter and gravitational field does not lead to the appearance of a singularity.'

In 1965 Penrose and Hawking formulated and proved 'incompleteness' theorems that convinced even Lifshitz and Khalatnikov that singularities in time ARE a necessary property of cosmological models of the general theory of relativity. Penrose and Hawking proved that under very general, physically reasonable conditions, a spacetime (that is, a solution to the Einstein equations) has a light ray (null geodesic) that suddenly ends ('incompleteness') sufficiently far in the past. They adroitly sidestep the problem of defining what a singularity actually is, by saying it is the 'place' where their light rays end. The proofs of incompleteness theorems are not hard. That's good. Unfortunately, they are by their very nature completely non constructive and provide no quantitative information at all about what a singularity really looks like.

In 1970, Belinski, Khalatnikov and Lifshitz revisited the work of 1963 and found that Khalatnikov and Lifshitz had missed something and that '... we shall show that there exists a general solution which exhibits a physical singularity with respect to time.' In 1982 they revised the 1970 proposal. Their work culminates in a series of fascinating, but very, very heuristic, statements about the possible existence of a class of singular solutions to the field equations. These heuristic statements are referred to as the 'BKl Conjectures'.

Next semester, we will rigorously formulate and prove the 'BKl Conjectures' for homogeneous spacetimes. That is, we will construct a set of initial data with positive measure which evolve into homogeneous, chaotically singular spacetimes that exhibit all of the BKl phenomenology. Most importantly, there are chaotic oscillations, growing in magnitude, whose distribution is governed by the continued fraction expansion of a parameter appearing in the initial data.

The lectures will be completely self contained. One doesn't need to know anything about general relativity; the Einstein field equations will be introduced from scratch. We will classify real, three dimensional Lie algebras, introduce tensor analysis and discuss the geometry of homogeneous spacetimes. We will also derive the basic properties of continued fractions and the Gauss map \$displaystyle x \mapsto \frac{1}{x} - \lfloor \frac{1}{x} \rfloor \$ from \$0,1 \$ to itself.

### Content

**Abstract**

This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory. In a more advanced part Bose-Einstein condensation, general mean field theory and critical phenomena will be addressed. Finally also various aspects of linear response theory will be discussed.

**Objective**

The goal of this course is to provide a solid introduction to the formalism, techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.

### Literature

- C. Misner, K. Thorne and J. Wheeler: Gravitation
- R. Wald - General Relativity
- N. Straumann - General Relativity with applications to Astrophysics

### Notice

- One might have, more provacatively, entitled the course: How does time end (in, Einstein's general relativity)? In a word, badly. Not in a whimper, nor in a crunch, but in something much more exotic.
- More, technically, what does a generic singular point, restricting time, in solutions to the Einstein gravitational field equations look like?

- Special cosmological solutions, such as Freedman's, do have singularities.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>ECTS</th>
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<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>10</td>
<td>4V+2U</td>
<td>G. Isidori</td>
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<tr>
<td>402-0861-00L</td>
<td>Statistical Physics</td>
<td>10</td>
<td>4V+2U</td>
<td>M. Sigrist</td>
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<tr>
<td>402-0830-00L</td>
<td>General Relativity</td>
<td>10</td>
<td>4V+2U</td>
<td>M. Gambardell</td>
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<tr>
<td>402-0873-65L</td>
<td>Partial Differential Equations of Quantum Physics</td>
<td>4</td>
<td>2V</td>
<td>I. M. Sigal</td>
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**Data: 06.12.2018 13:04**

**Autumn Semester 2015**

**Page 1053 of 1432**
ECTS
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only
W
Yes.
P. Widmayer
Lecturers
T. Holenstein
The student learns the fundamentals of Complexity Theory, as well as some of the more recent techniques. He not only understands the
Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed
Randomized Algorithms are algorithms that “flip coins” to take certain decisions. This concept extends the classical model of deterministic
Prerequisites /
notice
Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.
Outlook: In the following spring semester there is a seminar “Geometry: Combinatorics and Algorithms” that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

252-1407-00L
Algorithmic Game Theory
W
7 credits
3V+2U+1A
P. Widmayer
Abstract
Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed
goal. For instance, they are interested in getting high bandwidth for themselves, but don’t care about others, and the
same is true for computational load or download rates. Game theory provides a powerful well-suited model for the behaviour and
interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic
Aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish
behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments.
Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction design and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks

Lecture notes
No lecture notes.

Literature
"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Prerequisites / notice
Several copies of both books are available in the Computer Science library.
Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.
Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

252-0417-00L
Randomized Algorithms and Probabilistic Methods
W
7 credits
3V+2U+1A
A. Steger
Abstract
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks
Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.
Content
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes

252-4050-00L
Complexity Theory
W
6 credits
3V+2U
T. Holenstein
Abstract
Complexity Theory classifies problems according to the resources required in order to solve them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, NP, AM, PH, PSPACE, IP, EXP), and study circuit complexity.
Objective
The student learns the fundamentals of Complexity Theory, as well as some of the more recent techniques. He not only understands the basic results and techniques used to prove them, but also has insight in some of the technically more advanced theorems.
Content
Complexity Theory classifies problems according to the difficulty of solving them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, PSPACE, IP, EXP), and study the known relationship to uniform complexity. We study circuit complexity, and its relationship to uniform complexity. We also will study some circuit lower bounds for constant depth circuits, as well as results which explain why it is difficult to improve these results.
Selection: Further Realms

<table>
<thead>
<tr>
<th>Number</th>
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Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:

1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

Abstract

For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

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<td>4</td>
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<tr>
<td>227-0445-00L</td>
<td>Advanced Mathematical Signal Processing</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>H. G. Feichtinger</td>
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<td>Block course:</td>
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<td>Starts on October 8 and ends on November 26, 2015</td>
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<td>Thursdays 10-12 and 13-16</td>
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Abstract

Usually Fourier Analysis and Systems Theory emphasize the analogy between the different settings (continuous&discrete, periodic&non-period.). The author proposes a simple approach to generalized functions, based on a Banach space of test functions. The course provides the foundations to Banach Gelfand triples, but also concrete applications in signal processing (time-variant systems, sampling).

Objective

Deeper mathematical understanding of the foundations of signal processing and system theory. The setting of Banach Gelfand Triples allows to provide a framework that allows among others to discuss the relations between different settings (e.g. the generalized Fourier transform of functions on the Euclidean space and corresponding FFT-based routines).

Content

Time-Frequency Analysis and its discretized version, namely Gabor Analysis have required to develop a family of function spaces (the so-called modulation spaces, introduced by Feichtinger in the 80th) which is different from the usual Lebesgue spaces. There is a smallest space (called $S_0$) and a largest space (namely the dual space), which is a suitable reservoir of generalized functions relevant for the rigorous establishment of basic results in signal processing (sampling theorem, Poisson formula, Fourier inversion, etc.). The course will be centered about the basic properties of the Banach Gelfand triple $(S_0,L^2,S_0')$ (also called rigged Hilbert space), its use for signal processing and systems theory applications. In addition to classical questions we will also discuss the fundamental results of time-frequency analysis (Short-time Fourier transform, Gabor frames, Gabor multipliers, best approximation of operators by Gabor multipliers, identification of slowly varying channels using pilot tones, etc.).

Lecture notes

There will a script related to the course. In fact, material for a book project on the subject is developed while the course is given.

Prerequisites / notice

In principle a good understanding of concepts from linear algebra is sufficient. Of course, basic knowledge about functional analysis (Banach and Hilbert spaces, linear operators and linear functionals) is helpful. We will, however, explain all these concepts as we go along. We will not need background on Lebesgue integration or topological vector spaces (as usually required for the treatment of distributions).

Application Area

Only necessary and eligible for the Master degree in Applied Mathematics. One of the application areas specified must be selected for the category Application Area for the Master degree in Applied Mathematics. At least 8
### Atmospherical Physics

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<tr>
<th>Number</th>
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<tr>
<td>651-4911-00L</td>
<td>Climate and the Global Circulation of the Atmosphere</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>T. Schneider</td>
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</table>

**Abstract**
Key features of the surface climate (e.g., the wind and temperature distribution) can be understood by considering how basic physical processes such as the angular momentum and energy balance constrain global atmospheric circulations. This course gives an overview of the physical balances involved and explores some of their implications for maintaining the surface climate.

**Objective**
Understanding of the basic physical processes involved in maintaining the global circulation of the atmosphere and the surface climate (winds, temperature, precipitation, etc.). Ability to reason how climate may change on long timescales.

**Content**
Introduction to the physical balances and dynamical mechanisms governing global atmospheric circulations and the surface climate: angular momentum balance and its role in controlling winds; energy balance and its role in controlling temperatures; the hydrologic cycle and its role in controlling humidity and aridity; tracer transport and connections to the surface. The relative importance of mean circulations, transient eddies, and stationary eddies in these balances will be discussed, as will be the dynamics of their generation and maintenance.

The course gives an overview of the dominant processes that govern the surface climate, with a focus on phenomenology and order-of-magnitude physics that is applicable to climates generally, including those of Earth's distant past and of other planets.

**Lecture notes**

### Biology

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<th>Number</th>
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<tr>
<td>551-0015-00L</td>
<td>Biology I</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>R. Glockshuber, E. Hafen</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.

**Objective**
The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.

**Content**

1. Aufbau der Zelle
   - Kapitel 5: Struktur und Funktion biologischer Makromoleküle
   - Kapitel 6: Eine Tour durch die Zelle
   - Kapitel 7: Membranstruktur und Funktion
   - Kapitel 8: Einführung in den Stoffwechsel
   - Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie
   - Kapitel 10: Photosynthese
   - Kapitel 12: Der Zellzyklus
   - Kapitel 17: Vom Gen zum Protein

2. Allgemeine Genetik
   - Kapitel 13: Meiose und Reproduktionszyklen
   - Kapitel 14: Mendelsche Genetik
   - Kapitel 15: Die chromosomale Basis der Vererbung
   - Kapitel 16: Die molekulare Grundlage der Vererbung
   - Kapitel 18: Genetik von Bakterien und Viren
   - Kapitel 46: Tierische Reproduktion

**Lecture notes**
Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.

**Literature**
Das folgende Lehrbuch ist Grundlage für die Vorlesung Biologie I und II:


**Prerequisites / notice**

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<tr>
<td>636-0017-00L</td>
<td>Molecular Evolution, Phylogenetics and Phyloodynamics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>T. Stadler</td>
</tr>
</tbody>
</table>

**Abstract**
The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylogenomics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.
Objective
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:
- models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:
- epidemiology
- pathogen evolution
- macroevolution of species

Content
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes
Slides of the lecture will be available online.

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
- * Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics.

701-1415-00L  Population Biology  W  3 credits  2V

Abstract
This course provides an understanding of the basic concepts of population biology. It presents models regarding the dynamics and evolution of populations, and experimental designs for investigating population biology hypotheses (e.g., population growth, species interactions, epidemics, metapopulations, life history evolution, local adaptation, evolution of sex, and coevolution).

Objective
Students are able
- to describe and apply population biology models (e.g., growth, species interactions)
- to describe and apply epidemiological models
- to understand and apply evolutionary concepts (e.g., life history evolution, coevolution, evolution of sex) using population biology arguments and provide examples
- to apply population biology experiments

Content
Population growth, population regulation, predator-prey interactions, host-pathogen interactions, competition, metapopulations, life history evolution, local adaptation, mating systems, sexual selection, coevolution.

Lecture notes
Handouts of lectures

Literature
Recommended:

Computational Electromagnetics

Number  Title  Type  ECTS  Hours  Lecturers

227-0707-00L  Optimization Methods for Engineers  W  3 credits  2G  C. Hafner, P. Leuchtmann

Abstract
First half of the semester: Introduction to the main methods of numerical optimization with focus on stochastic methods such as genetic algorithms, evolutionary strategies, etc.
Second half of the semester: Each participant implements a selected optimizer and applies it on a problem of practical interest.

Objective
Numerical optimization is of increasing importance for the development of devices and for the design of numerical methods. The students shall learn to select, improve, and combine appropriate procedures for efficiently solving practical problems.

Content
Typical optimization problems and their difficulties are outlined. Well-known deterministic search strategies, combinatorial minimization, and evolutionary algorithms are presented and compared. In engineering, optimization problems are often very complex. Therefore, new techniques based on the generalization and combination of known methods are discussed. To illustrate the procedure, various problems of practical interest are presented and solved with different optimization codes.

Lecture notes
PDF file see http://alphard.ethz.ch/hafner/Vorles/lect.htm

Prerequisites / notice
Lecture in the first half of the semester, exercises in form of small projects in the second half, presentation of the results in the last week of the semester.

227-2037-00L  Physical Modelling and Simulation  W  5 credits  4G  C. Hafner, J. Leuthold, J. Smajic

Abstract
Physical modelling plays an important role in the analysis and design of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained.

Content
Since the fabrication and characterization of micro- and nanostructures is difficult, expensive, and time-consuming, numerical modelling drastically reduced the design process. Although many commercial software packages are available, it is important to know the drawbacks and difficulties of the numerical methods behind them and to be able to validate the results obtained with such packages.
First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the problems to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electromagnetics to multiphysics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

Control and Automation

Number  Title  Type  ECTS  Hours  Lecturers

151-0563-01L  Dynamic Programming and Optimal Control  W  4 credits  3G  R. D’Andrea

Abstract
Introduction to Dynamic Programming and Optimal Control.

Objective
Covers the fundamental concepts of Dynamic Programming & Optimal Control.

Content
Dynamic Programming Algorithm; Deterministic Systems and shortest path problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

### Economics

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<td>363-0537-00L</td>
<td>Resource and Environmental Economics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. Bretschger, A. Brausmann</td>
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</table>

**Abstract**

Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

**Objective**

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

### Literature


### Prerequisites / notice

Prerequisites / notice

Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

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### 363-0503-00L Principles of Microeconomics

**Abstract**

The course introduces basic principles, problems and approaches of microeconomics.

**Objective**

The course includes the following main topics:

- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

**Lecture notes**

Lecture notes and reference material can be downloaded from Moodle.

**Literature**


The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book: N. Gregory Mankiw and Mark P. Taylor (2014), "Microeconomics", 3rd edition, South-Western Cengage Learning.

Complementary:


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### 363-0565-00L Principles of Macroeconomics

**Abstract**

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

**Objective**

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.
This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society’s resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

### Environmental Science

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0535-00L</td>
<td>Environmental Soil Physics/Vadose Zone Hydrology</td>
<td>W</td>
<td>3</td>
<td>2G+2U</td>
<td>D. Or</td>
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</table>

**Abstract**
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

**Objective**
Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

**Content**
Weeks 1 to 3: Physical Properties of Soils and Other Porous Media
- Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior
- Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.
- Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity
- Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing
- Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
  - Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement
  - Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.
  - Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
  - Midterm exam
  - Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.
  - Part 3 - Use of Hydrus model for simulation of unsaturated flow
- Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.
- Week 12 to 13: Solute Transport in Soils
  - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.
- Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.
- Additional topics:
  - Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
  - Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

**Lecture notes**
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

**Literature**
Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

### Finance

This lecture is intended for students who would like to learn more on equity derivatives modelling and pricing.

Lecturers
3G

Fundamentals in signal processing, detection/estimation, and machine learning.

Course material Script, computer demonstrations, exercises and problem solutions

Quantitative models for European option pricing (including stochastic volatility and jump models), volatility and variance derivatives, American and exotic options.

After introducing fundamental concepts of mathematical finance including no-arbitrage, portfolio replication and risk-neutral measure, we will present the main models that can be used for pricing and hedging European options e.g. Black-Scholes model, stochastic and jump-diffusion models, and highlight their assumptions and limitations. We will cover several types of derivatives such as European and American options, Barrier options and Variance-Swaps. Basic knowledge in probability theory and stochastic calculus is required. Besides attending class, we strongly encourage students to stay informed on financial matters, especially by reading daily financial newspapers such as the Financial Times or the Wall Street Journal.

Lecture notes
Script.

Prerequisites / notice
Basic knowledge of probability theory and stochastic calculus. Asset Pricing.

401-8913-00L Advanced Corporate Finance I (University of Zurich) W 3 credits 2V University lecturers

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: MEOC0288

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
The course applies the basic concepts of corporate finance learnt in earlier courses to a variety of problems in corporate finance. Examples are valuation, takeovers, the measurement of value created, mergers, capital structure, project finance, and foreign direct investment. These are studied in the context of real cases.

Image Processing and Computer Vision

Number Title Type ECTS Hours Lecturers
227-0447-00L Image Analysis and Computer Vision W 6 credits 3V+1U G. Székely, O. Göksel, L. Van Gool

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice
Prerequisites:
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

Information and Communication Technology

Number Title Type ECTS Hours Lecturers
227-0427-00L Signal and Information Processing: Modeling, Filtering, Learning W 6 credits 4G H.A. Loeliger

Abstract
Fundamentals in signal processing, detection/estimation, and machine learning.

I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparseness.

Objective
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

Content
The course language is English.

Lecture notes
Lecture notes.

Prerequisites:
- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

**The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications.**

**Objective**
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are "linearity" and "probability". In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMSMSE filtering, the LMS algorithm, and the Viterbi algorithm.

**Content**
Discrete-time linear systems and the z-transform.
Discrete time and continuous time: forth and back.
Digital filters.
DFT.
Elements of probability theory.
Discrete-time stochastic processes.
Elements of detection theory and estimation theory.
Linear estimation and filtering.
Wiener filter.
LMS algorithm.
Viterbi algorithm.

**Lecture notes**
Lecture Notes.

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**Information Theory I**

**Number** 227-0417-00L

**Abstract**
This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

**Objective**
The fundamentals of Information Theory including Shannon's source coding and channel coding theorems

**Content**
The entropy rate of a source, Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity

**Literature**
T.M. Cover and J. Thomas, Elements of Information Theory (second edition)

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**Transport Phenomena I**

**Number** 327-1201-00L

**Abstract**
Phenomenological approach to "Transport Phenomena" based on balance equations supplemented by thermodynamic considerations to formulate the undetermined fluxes in the local species mass, momentum, and energy balance equations; fundamentals, applications, and simulations

**Objective**
The teaching goals of this course are on five different levels:
(1) Deep understanding of fundamentals: local balance equations, constitutive equations for fluxes, entropy balance, interfaces, idea of dimensionless numbers, ...
(2) Ability to use the fundamental concepts in applications
(3) Insight into the role of boundary conditions
(4) Knowledge of a number of applications
(5) Flavor of numerical techniques: finite elements, finite differences, lattice Boltzmann, Brownian dynamics, ...

**Content**
Approach to Transport Phenomena
Diffusion Equation
Brownian Dynamics
Refreshing Topics in Equilibrium Thermodynamics
Balance Equations
Forces and Fluxes
Measuring Transport Coefficients
Pressure-Driven Flows
Heat Exchangers
Complex Fluids

**Lecture notes**
A detailed manuscript is provided; this manuscript will be developed into a book entitled "A Modern Course in Transport Phenomena" by David C. Venerus and Hans Christian Öttinger

**Literature**

**Prerequisites / notice**
Complex numbers, Vector analysis (integrability; Gauss' divergence theorem). Laplace and Fourier transforms. Ordinary differential equations (basic ideas). Linear algebra (matrices; functions of matrices; eigenvectors and eigenvalues; eigenfunctions). Probability theory (Gaussian distributions; Poisson distributions; averages; moments; variances; random variables). Numerical mathematics (integration), Equilibrium thermodynamics (Gibbs' fundamental equation; thermodynamic potentials; Legendre transforms). Maxwell equations. Programming and simulation techniques (Matlab, Monte Carlo simulations).

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**Advanced Quantum Chemistry**

**Number** 529-0003-00L

**Abstract**
Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer.

Examples are:
* Operators derived from principles of relativistic quantum mechanics
* Relativistic effects + methods of relativistic quantum chemistry
* Open-shell molecules + spin-density functional theory
* New electron-correlation theories

**Literature**
* New electron-correlation theories

**Prerequisites / notice**
* New electron-correlation theories
The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

Content
1) Introductory lecture: basics of quantum mechanics and quantum chemistry
2) Einstein's special theory of relativity and the (classical) electromagnetic interaction of two charged particles
3) Klein-Gordon and Dirac equation; the Dirac hydrogen atom
4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
6) Relativistic effects in chemistry and the emergence of spin
7) Spin in density functional theory
8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
9) Quantum chemistry without the Born-Oppenheimer approximation.

Lecture notes
A set of detailed lecture notes will be provided, which will cover the whole course.

Literature
2) F. Schwabl: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997
3) R. McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992

Prerequisites / notice
Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

Simulation of Semiconductor Devices

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<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>227-0157-00L</td>
<td>Semiconductor Devices: Physical Bases and Simulation</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Schenk</td>
</tr>
</tbody>
</table>

Objective
The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

Content
The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions.

The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

Prerequisites / notice

Systems Design

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
<td>F. Schweitzer, P. Mavrodiev</td>
</tr>
</tbody>
</table>

Objective
A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyze the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics
The course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

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

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

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

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

#### Theoretical Physics

In the Master's programme in Applied Mathematics 402-0205-00L Quantum Mechanics I is eligible as a course unit in the application area Theoretical Physics. But only if 402-0204-00L Theoretical Physics wasn't or isn't recognised for credits (neither in the Bachelor's nor in the Master's programme). For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

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<tbody>
<tr>
<td>402-0809-00L</td>
<td>Introduction to Computational Physics</td>
<td>W</td>
<td>8</td>
<td>2V+2</td>
<td>H. Herrmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions</td>
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<tr>
<td>Prerequisites</td>
<td>Self-study tasks (discussion exercises, Vensim exercises), are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.</td>
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<tr>
<td>Literature</td>
<td>Lecture and exercise lessons in english, exams in German or in English</td>
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<tr>
<td>402-2203-01L</td>
<td>Classical Mechanics</td>
<td>W</td>
<td>7</td>
<td>4V+2</td>
<td>C. Anastasiou</td>
</tr>
<tr>
<td>Abstract</td>
<td>A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations. Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.</td>
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<tr>
<td>Objective</td>
<td>This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes will be provided.</td>
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<tr>
<td>Literature</td>
<td>No specific book is used for the course. Relevant literature will be cited in the course.</td>
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#### Quantum Field Theory I

This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity.

Topics include:
- Relativistic quantum mechanics
- Quantisation of bosonic and fermionic fields
- Interactions in perturbation theory
- Scattering processes and decays
- Radiative corrections

The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.

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</thead>
<tbody>
<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>W</td>
<td>10</td>
<td>4V+2</td>
<td>G. Isidori</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.</td>
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#### General Relativity

Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.
Objective: Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.

Literature:
- C. Misner, K. Thorne and J. Wheeler: Gravitation
- S. Carroll - Spacetime and Geometry: An Introduction to General Relativity
- R. Wald - General Relativity
- S. Weinberg - Gravitation and Cosmology
- N. Straumann - General Relativity with applications to Astrophysics

**Electives Theoretical Physics**

**Transportation Science**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0417-00L</td>
<td>Transport Planning Methods</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>K. W. Axhausen</td>
</tr>
</tbody>
</table>

**Objective**
- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

**Content**
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

**Prerequisites / notice**
Basic knowledge of linear programming.

**Seminars and Semester Papers**

**Seminars**
Early enrolments for seminars in myStudies are encouraged, so that we will recognize need for additional seminars in a timely manner. Some seminars have waiting lists. Nevertheless, register for at most two mathematics seminars. In this case, you express a stronger preference for the seminar for which you register earlier.

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<tbody>
<tr>
<td>401-3050-65L</td>
<td>Student Seminar in Combinatorics: Linear Complementarity</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>K. Fukuda</td>
</tr>
</tbody>
</table>

**Objective**
To understand the importance of linear complementarity as a common generalization of linear programming, bimatrix games and convex quadratic programming.

**Content**
The Linear Complementarity Problem (LCP) was introduced in mid 1960's (1965-67) by Lemke and Cottle-Dantzig as a common generalization of linear programming, bimatrix game and convex quadratic programming.

The problem is NP-hard in general, but there are many subclasses of LCP that are in P (polynomially solvable) or suspected to be in P. The reason for the possible polynomial solvability is that these studied subclasses (e.g. P-matrix LCPs and positive-definite LCPs) can be formulated as a problem which admits a solution that has a succinct certificate for its correctness. Moreover, there are elegant combinatorial abstractions of these subclasses.

In this seminar, we study the most important papers/books, both old and new, in the theory of LCP, and aim at understanding what is crucial lack of knowledge in proving or disproving existing conjectures.

**Prerequisites / notice**
Basic knowledge of linear programming.

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</thead>
<tbody>
<tr>
<td>401-3110-65L</td>
<td>Monstrous Moonshine</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>C. A. Keller</td>
</tr>
</tbody>
</table>

**Objective**
We study Monstrous Moonshine, the surprising connection between modular forms and the Monster group.

**Content**
To understand the equation $196884 = 196883 + 1$.

**Prerequisites / notice**
Algebra I and II. Some familiarity with modular forms and Lie algebras is helpful, but not crucial: all necessary concepts will be introduced in the early talks.

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<tbody>
<tr>
<td>401-3320-65L</td>
<td>Algebraic Groups and Actions</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>B. R. Doran</td>
</tr>
</tbody>
</table>
We will discuss various additional topics in Functional Analysis: unitary representations of abelian and non-abelian groups, Choquet's theorem on extremal points, distributions, amenability and property (T).

### 401-4460-62L Functional Analysis III

**Number of participants limited to 12.**

**Prerequisites:** Functional Analysis I and II

**Abstract**
We will discuss various additional topics in Functional Analysis: unitary representations of abelian and non-abelian groups, Choquet's theorem on extremal points, distributions, amenability and property (T).

**Semester Paper**
This seminar should provide an overview of the mathematical principles and fundamental concepts behind computerized tomography. The seminar is held once a year and complements the courses Computational Geometry and Geometric Graphs: Combinatorics & Algorithms. Students of the seminar will present original research papers, some classic and some of them very recent. The seminar is a good preparation for a master, diploma, or semester thesis in the area.

**Objective**
Each student is expected to read, understand, and elaborate on a selected research paper. To this end, (s)he should give a 45-min. presentation about the paper. The process includes:

- getting an overview of the related literature;
- understanding and working out the background/motivation: why and where are the questions addressed relevant?
- understanding the contents of the paper in all details;
- selecting parts suitable for the presentation;
- presenting the selected parts in such a way that an audience with some basic background in geometry and graph theory can easily understand and appreciate it.

**Prerequisites / notice**
The seminar is suited for Bachelor and Master students. Some knowledge in linear functional analysis and algebra is required.

**Number of participants limited to 10.**

**Literature**
A list of papers for presentations will be distributed at the beginning of the seminar.

**Registration**
Successful completion of that course is a prerequisite for participation in the seminar.

**Limited number of participants.**

**Seminar SAT**
The seminar builds heavily on the material covered in the course "Boolean Satisfiability-Combinatorics and Algorithms." Successful completion of that course is a prerequisite for participation in the seminar.

**Study and presentation of research papers from the literature on "Boolean Satisfiability-Combinatorics and Algorithms".**

**Number of participants 15 up to 20.**

**Objective**
Study and presentation of research papers from the literature on "Boolean Satisfiability-Combinatorics and Algorithms". Goal of this seminar is to study and present, in continuation of the course "Boolean Satisfiability-Combinatorics and Algorithms", research papers from the literature. A list of papers for presentations will be distributed at the beginning of the seminar.

**Prerequisites / notice**
The seminar is suited for Bachelor and Master students. Some knowledge in linear functional analysis and algebra is required.

**Limited number of participants.**

**Registration**
Successful completion of that course is a prerequisite for participation in the seminar.

**Semester Papers**
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3750-01L</td>
<td>Semester Paper</td>
<td>W</td>
<td>8</td>
<td>11A</td>
<td>Professors</td>
</tr>
</tbody>
</table>
Abstract
Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

401-3750-02L Semester Paper  ■
No direct enrolment to this course unit in myStudies.
Please fill in the online application form.
Requirements and application form under
www.math.ethz.ch/intranet/students/study-
administration/theses.html
(Afterwards the enrolment will be done by the Study Administration.)

Abstract
Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

401-3750-03L Semester Paper  ■
No direct enrolment to this course unit in myStudies.
Please fill in the online application form.
Requirements and application form under
www.math.ethz.ch/intranet/students/study-
administration/theses.html
(Afterwards the enrolment will be done by the Study Administration.)

Abstract
Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATH.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Target audience:
Third year Bachelor students;
Master students who cannot document to have received an adequate training in working scientifically.

Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later. Optional for Bachelor and Master students with matriculation until or before the spring semester 2014.

Example: You matriculated in the autumn semester 2013 into the first semester of the Bachelor programme, are now in the third year and plan to matriculate in the autumn semester 2016 into the first semester of the Master programme. In this case, you don't need "Scientific Works in Mathematics" in order to complete the Bachelor degree, but for the Master degree you will need it. In this case, we recommend that you register for "Scientific Works in Mathematics" in the autumn semester 2015 or spring semester 2016.

Directive

Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-4990-00L Master's Thesis  ■
Only students who fulfill the following criteria are allowed to begin with their master's thesis:
a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to
gain admission to the master programme.

No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html (Afterwards the enrolment will be done by the Study Administration.)

Abstract

The master's thesis concludes the study programme. Writing up the master's thesis allows students to independently produce a major piece of work on a mathematical topic. It generally involves consulting the literature, solving any ensuing problems, and putting together the results in writing.

### Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
<tr>
<td>401-5990-00L</td>
<td>Zurich Graduate Colloquium</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>A. Iozzi, University lecturers</td>
</tr>
<tr>
<td>401-5110-00L</td>
<td>Number Theory Seminar</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>Ö. Imamoglu, P. S. Jossen, E. Kowalski, P. D. Nelson, R. Pink</td>
</tr>
<tr>
<td>401-5350-00L</td>
<td>Analysis Seminar</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>M. Struwe, D. Christodoulou, F. Da Lio, N. Hungerbühler, T. Kappeler, T. Rivière, D. A. Salamon</td>
</tr>
<tr>
<td>401-5530-00L</td>
<td>Geometry Seminar</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>M. Burger, M. Einsiedler, A. Iozzi, U. Lang, V. Schroeder, A. Sisto</td>
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<tr>
<td>401-5580-00L</td>
<td>Symplectic Geometry Seminar</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>D. A. Salamon, P. Biran, A. Cannas da Silva</td>
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<tr>
<td>401-5330-00L</td>
<td>Talks in Mathematical Physics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>A. Cattaneo, G. Felder, M. Gabriedel, G. M. Graf, H. Knörrer, T. H. Willwacher, University lecturers</td>
</tr>
<tr>
<td>401-5600-00L</td>
<td>Seminar on Stochastic Processes</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>J. Bertoin, A. Knowles, A. Nikeghbali, P. Nolin, B. D. Schlein, A.S. Sznitman, W. Werner</td>
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<tr>
<td>401-5910-00L</td>
<td>Talks in Financial and Insurance Mathematics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>P. Embrechts, M. Schweizer, M. Soner, J. Teichmann, M. V. Wüthrich</td>
</tr>
<tr>
<td>401-5900-00L</td>
<td>Optimization Seminar</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>R. Weismantel, R. Zenklusen</td>
</tr>
</tbody>
</table>

**Objective**

To expose graduate students to ongoing research activities (including applications) in the domain of optimization.

**Content**

Lectures on current topics in optimization
401-5960-00L  Colloquium on Mathematics, Computer Science, and Education  E- 0 credits  N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz

Abstract
Subject didactics for mathematics and computer science teachers.


Abstract
Research colloquium
Prerequisites / notice Occasionally, talks may be delivered in German.


Abstract
Research colloquium
Objective The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.

251-0100-00L  Computer Science Colloquium  E- 0 credits  2K Lecturers

Abstract
Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.

Objective Top international computer scientists take the floor at the distinguished computer science colloquium. Our guest speakers present impacting topics across various areas of the discipline. The colloquium series is held every semester and also includes inaugural and farewell lectures of the department's professors. The colloquium is a noteworthy event for all graduate students. Outside attendance is equally welcome.

Content Eingeladene Vorträge aus dem gesamten Bereich der Informatik, zu denen auch Auswärtige kostenlos eingeladen sind. Zu Semesterbeginn erscheint jeweils ein ausführliches Programm.

► Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>406-2004-AAL</td>
<td>Algebra II</td>
<td>E-</td>
<td>5</td>
<td>11R</td>
<td>E. Kowalski</td>
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<tr>
<td>Abstract</td>
<td>Galois theory and Representations of finite groups, algebras.</td>
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<tr>
<td>Objective</td>
<td>The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.</td>
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<tr>
<td>Content</td>
<td>Introduction to fundamentals of Galois theory, and representation theory of finite groups and algebras</td>
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<tr>
<td>Literature</td>
<td>Representation theory of finite groups and algebras</td>
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<tr>
<td>Literature</td>
<td>S. Lang, Algebra, Springer Verlag</td>
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<tr>
<td>Literature</td>
<td>B.L. van der Waerden: Algebra I und II, Springer Verlag</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>I.R. Shafarevich, Basic notions of algebra, Springer verlag</td>
<td></td>
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<tr>
<td>Literature</td>
<td>G. Mislin: Algebra I, vdf Hochschulverlag</td>
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<tr>
<td>Literature</td>
<td>U. Stammbach: Algebra, in der Polybuchhandlung erhältlich</td>
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<tr>
<td>Literature</td>
<td>G. Wüstholz, Algebra, vieweg-Verlag, 2004</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>J-P. Serre, Linear representations of finite groups, Springer Verlag</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Algebra I</td>
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</tbody>
</table>

406-2005-AAL  Algebra I and II  E- 12 credits  26R E. Kowalski

Abstract
Enrolment only for MSc students who need this course as additional admission requirement.

Introduction and development of some basic algebraic structures - groups, rings, fields including Galois theory, representations of finite groups, algebras.

The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.
### Content

- Basic notions and examples of groups:
  - Subgroups, Quotient groups and Homomorphisms,
  - Group actions and applications

- Basic notions and examples of rings:
  - Ring Homomorphisms,
  - Ideals, and quotient rings, rings of fractions
  - Euclidean domains, Principal ideal domains, Unique factorization domains

- Basic notions and examples of fields:
  - Field extensions, Algebraic extensions, Classical straight edge and compass constructions

- Fundamentals of Galois theory
- Representation theory of finite groups and algebras

### Literature

- S. Lang, *Algebra*, Springer Verlag
- B.L. van der Waerden: *Algebra I und II*, Springer Verlag
- I.R. Shafarevich, *Basic notions of algebra*, Springer verlag
- G. Mislin: *Algebra I*, vdf Hochschulverlag
- U. Stammbach: *Algebra, in der Polybuchhandlung erhältlich*
- G. Wüstholz, *Algebra, vieweg-Verlag, 2004*
- J-P. Serre, *Linear representations of finite groups, Springer Verlag*

### 406-2303-AAL

#### Complex Analysis

<table>
<thead>
<tr>
<th>Enrolment only for MSc students who need this course as additional admission requirement.</th>
</tr>
</thead>
<tbody>
<tr>
<td>R. Pandharipande</td>
</tr>
</tbody>
</table>

#### Abstract

Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, conformal mappings, Riemann mapping theorem.

#### Literature

- B. Palika: "An introduction to complex function theory."
- R. Remmert: *Theory of Complex Functions.. Springer Verlag*

E.Hille: *Analytic Function Theory. Springer Publication*

### 406-2284-AAL

#### Measure and Integration

<table>
<thead>
<tr>
<th>Enrolment only for MSc students who need this course as additional admission requirement.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. Schweizer</td>
</tr>
</tbody>
</table>

#### Abstract

Introduction to the abstract measure theory and integration, including the following topics: Lebesgue measure and Lebesgue integral, Lp-spaces, convergence theorems, differentiation of measures, product measures (Fubini’s theorem), abstract measures, Radon-Nikodym theorems, probabilistic language.

#### Literature

1. Lecture notes by Professor Michael Struwe (http://www.math.ethz.ch/~struwe/Skripten/AnalysisIII-SS2007-18-4-08.pdf)
2. L. Evans and R.F. Gariepy "Measure theory and fine properties of functions"
3. Walter Rudin "Real and complex analysis"
4. R. Bartle The elements of Integration and Lebesgue Measure

#### Prerequisites / notice

The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.

### 406-2554-AAL

#### Topology

<table>
<thead>
<tr>
<th>Enrolment only for MSc students who need this course as additional admission requirement.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. Bühler</td>
</tr>
</tbody>
</table>

#### Abstract

Topological spaces, continuous maps, connectedness, compactness, separation axioms, metric spaces, quotient spaces, homotopy, fundamental group and covering spaces, van Kampen Theorem, surfaces and manifolds.

#### Literature

- Klaus Jänich: *Topologie* (Springer-Verlag)
- http://www.springerlink.com/content/978-3-540-21393-2/fulltext/#section=592889&page=1
- James Munkres: *Topology* (Prentice Hall)
- William Massey: *Algebraic Topology: an Introduction* (Springer-Verlag)
- Alan Hatcher: *Algebraic Topology* (Cambridge University Press)

#### Prerequisites / notice

The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.

### 406-2604-AAL

#### Probability and Statistics

<table>
<thead>
<tr>
<th>Enrolment only for MSc students who need this course as additional admission requirement.</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. van de Geer</td>
</tr>
</tbody>
</table>

#### Abstract

Introduction to probability and statistics with many examples, based on chapters from the books "Probability and Random Processes" by G. Grimmett and D. Stirzaker and "Mathematical Statistics and Data Analysis" by J. Rice.

#### Objective

The goal of this course is to provide an introduction to the basic ideas and concepts from probability theory and mathematical statistics. In addition to a mathematically rigorous treatment, also an intuitive understanding and familiarity with the ideas behind the definitions are emphasized. Measure theory is not used systematically, but it should become clear why and where measure theory is needed.

#### Content

- Probability:
  - Chapters 1-5 (Probabilities and events, Discrete and continuous random variables, Generating functions) and Sections 7.1-7.5 (Convergence of random variables) from the book "Probability and Random Processes". Most of this material is also covered in Chap. 1-5 of "Mathematical Statistics and Data Analysis", on a slightly easier level.
- Statistics:
  - Sections 8.1 - 8.5 (Estimation of parameters), 9.1 - 9.4 (Testing Hypotheses), 11.1 - 11.3 (Comparing two samples) from "Mathematical Statistics and Data Analysis".

---

Functional Analysis I
Enrolment only for MSc students who need this course as additional admission requirement.

Baire category; Banach spaces and linear operators; Fundamental theorems: Open Mapping Theorem, Closed Range Theorem, Uniform Boundedness Principle, Hahn-Banach Theorem; Convexity; reflexive spaces; Spectral theory.

Lecture notes
Lecture notes by Professor Michael Struwe (http://www.math.ethz.ch/~struwe/Skripten/FA-I-II-26-8-08.pdf)
or Lecture notes by Prof. Einsiedler and Ward (https://dl.dropboxusercontent.com/u/2098511/FAnotes.pdf)

Literature
Numerous texts in English or German

Fundamentals of Mathematical Statistics
Enrolment only for MSc students who need this course as additional admission requirement.

The course covers the basics of inferential statistics.

Mathematics Master - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
<th>Eligibility</th>
</tr>
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<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
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</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Medicinal and Industrial Pharmaceutical Sciences Master

Conclusive Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>535-0030-00L</td>
<td>Therapeutic Proteins</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>C. Halin Winter, D. Neri</td>
</tr>
</tbody>
</table>

**Abstract**
In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.

**Objective**
Students know and understand:
- basic mechanisms and regulation of the immune response
- the pathogenic mechanisms of the most important immune-mediated disorders
- the most frequently used expression systems for the production of therapeutic proteins
- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

**Content**
The course consists of two parts:

In a first part, students will complete their training in pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.

The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

**Lecture notes**
Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

**Literature**
- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

<table>
<thead>
<tr>
<th>Number</th>
<th>Pharmacology and Toxicology III</th>
<th>O</th>
<th>2</th>
<th>2G</th>
<th>M. Detmar, U. Quitterer</th>
</tr>
</thead>
</table>

**Abstract**
The course is divided into two parts. The first part provides a detailed understanding of drugs and pharmacotherapy of infectious diseases and cancer. The second part gives an overview of the field of pharmacogenomics with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

**Objective**
The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects of drug therapy in the fields of infectious diseases and cancer. The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

**Content**
Topics include the pharmacology and pharmacotherapy of infectious diseases and cancer. In the field of pharmacogenomics, the course is focused on genetics, genome-wide association studies, genetic disease predisposition, examples of genetic variability of drug metabolism and drug responses, identification of new drug targets, relevance of pharmacogenomics for clinical drug development, and toxicogenomics.

**Lecture notes**
A script is provided for each lecture course. The scripts define important and exam-relevant contents of lectures. Scripts do not replace the lecture.

**Literature**
Recommended reading:
The classic textbook in Pharmacology:
Goodman and Gilman’s The Pharmacological Basis of Therapeutics
Laurence Brunton, Bruce Chabner, Bjorn Knollman.
12th edition - 1808 pages

or
Klaus Aktories, Ulrich Förstermann, Franz Hofmann, Klaus Starke.
Allgemeine und spezielle Pharmakologie und Toxikologie.
11th edition - 1216 pages
2013; Urban & Fischer (Elsevier, München)

<table>
<thead>
<tr>
<th>Number</th>
<th>Pharmacoepidemiology and Drug Safety</th>
<th>O</th>
<th>3</th>
<th>2G</th>
<th>S. Russmann</th>
</tr>
</thead>
</table>

**Abstract**
Introduction of principles of pharmacoepidemiology and epidemiology in addressing drug related questions in the population and of epidemiologic perspectives for health care management.
In parallel appropriate tools to critique pharmacoepidemiologic studies in medical literature will be given and applied.

**Objective**
Objectives:
- To familiarize participants with the principles of pharmacoepidemiology and epidemiology in addressing drug related questions with concern to the use, effects and risks of medicinal products in a large population.
- To introduce participants to fundamental statistical, economic and epidemiological concepts and methods.
- To provide the appropriate tools to critique pharmacoepidemiologic studies in the literature and to critically read and understand papers in the medical literature which relate to drug benefits, risks, and costs.
- To address controversial topics in drug use and benefit-risk assessment, and to critically appraise the outcome of drug therapy.
- To equip participants with skills to facilitate further studies in these areas.

**Content**
The contribution of epidemiology to the study of drug uses, effects and risks:
- Pharmacoepidemiology study methodologies, concepts and strategies,
- Detection and identification of unintended drug effects (pharmacovigilance),
- Quantifying unintended effects and drug interactions,
- Bias and confounding by indication,
- Drug utilization

Pharmacoepidemiology and outcome assessment of drug therapy.
Meta-analysis in pharmacoepidemiology.
Pharmacoepidemiology and regulatory decision making in drug safety

**Lecture notes**
This course will be a combination of formal lectures, group discussions and self-directed project work. Course material will be taught through seminars, case studies and group projects. Reading material and scripts will be given for each week.

Drug Seminars I

6 credit points are awarded after successful presentation in the Seminar Week. - Strictly for students enrolled in the Master programmes Pharmaceutical Sciences or MIPS.

Objective
Drug therapy is nothing less than interference with a highly complex biological system, which is affected by various internal and external factors. A profound understanding of drug effects thus requires a transdisciplinary approach of investigation. The drug seminars provide a platform for the presentation and discussion of these transdisciplinary approaches for the investigation of drug action.

Content
The faculty members of the Institute of Pharmaceutical Sciences offer specific projects from different areas of the pharmaceutical sciences, each of which is elaborated by a small group of students (4-8). Each group is tutored by a faculty member. The objective of this work is to achieve an in-depth understanding of the problem investigated and to present the results of the work to an audience composed of all students participating in the drug seminar and the faculty of the Institute of Pharmaceutical Sciences. Presentations will take place in the framework of a dedicated mini-symposium, which is part of the external seminar week. The possibility exists to invite external experts from industry or the public health sector to participate in the mini-symposium. Students are strongly encouraged to make use of this option and will again be supported in these efforts by the faculty members.

Drug Delivery and Drug Targeting

The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

Content
The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Literature

Clinical Chemistry II

Objective
Detailed knowledge on the implementation and interpretation of clinical laboratory diagnostic tests. Competence to interpret selected tests.

Content
Internal and external quality control, point-of-care analytics, analytics of kidney stones, tumor markers, diagnosis of HIV and hepatitis, pharmacogenetics, thyroid function, bone metabolism and laboratory diagnosis of hypertension.

Literature
- Jürgen Hallbach, Klinische Chemie und Hämatologie für den Einstieg, Thieme Verlag
- Harald Renz, Praktische Labordiagnostik, de Gruyter Verlag
- Walter Guder, Das Laborbuch für Klinik und Praxis, Elsevier Verlag
- Lothar Thomas, Labor und Diagnose, TH Books
- William Marshall, Clinical Chemistry, Mosby Ltd.
- Alan H.B. Wu, Tietz, Clinical Guide to Laboratory Tests, Saunders
- Rothman K, Greenland S; Modern Epidemiology, 2nd ed. Lippincott, Philadelphia, 1998
- Strom B; Pharmacoepidemiology, 3rd ed. Wiley, Chichester, 2000
- Strom B; Pharmacoepidemiology, 2nd ed. Lippincott, Philadelphia, 1998
- Rothman K, Greenland S; Modern Epidemiology, 3rd ed. Wiley, Chichester, 2000

Biopharmaceutics and Drug Metabolism

Limited selection of lectures on the implementation and interpretation of clinical laboratory diagnostic tests. Competence to interpret selected tests.

Literature
A. Koepf

Biotransformation of Drugs and Xenobiotics

Objective
Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.

Content
Major reactions of biotransformation. Major enzymes and reaction partners involved in the biotransformation of drugs and xenobiotics. Recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.

Literature

Patents

Objective
Basic knowledge in the field of intellectual property, especially of patents and trademarks, with particular emphasis on the chemical, pharmaceutical and biotech field.

Literature
Content
1. Introduction into industrial property (patents, trademarks, industrial designs);
2. Prosecution of patent applications (patentability);
3. Patent information (patent publications, databases, searches);
4. Exploitation and enforcement of patents (possibilities of exploitation, licenses, parallel imports, scope of protection, patent infringement);
5. Peculiarities in pharmacines and medicine (supplementary protection certificates, experimental use exemption, therapy and diagnosis, medical indication);
6. Social, political and ethical aspects (patents and prices for medicinal products, traditional knowledge and ethnomedical, bioprospeting and biocracy, human DNA inventions);
7. Trademarks, types of trademarks, grounds for refusal, peculiarities of pharma trademarks.

Lecture notes
A script is available in electronic form during the lecture.

Literature

Compensatory Courses

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<tr>
<td>535-0310-00L</td>
<td>Glycobiology in Drug Development</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>V. I. Otto</td>
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</table>

Abstract
Protein-based drugs constitute around 25% of new approvals and most of them are glycoproteins. Using selected examples the course aims at providing insight into our present knowledge on glycosylation-activity relationships and the production and analysis of glycoprotein-based drugs.

Objective
- Gaining insight into the glycobiology of therapeutically used glycoproteins. This implies knowing and understanding: the major types of protein-linked glycans and their biosynthesis - the most important expression systems for production of recombinant glycoproteins - methods used to alter or manipulate glycosylation - the most prominent clinically used glycoproteins and how glycosylation influences their therapeutic profile.
- Current methods for the qualitative and quantitative characterization of glycoproteins and being able to apply this knowledge in other contexts.

Content
lecture plan:
1. Proteins wearing a "sugar dress". Glycans in cell-cell communication and molecular recognition in multicellular organisms
2. Tissue plasminogen activator (t-PA), glucocerebrosidase and the biosynthesis of N-glycans
3. PSGL-1 and the biosynthesis of O-glycans;
P-selectin and other lectins
4. The glycoprotein hormones and the production and analysis of therapeutic glycoproteins
Monoclonal antibodies and the modification of their therapeutic profile through glycoengineering
6. EPO "the same but different"
7. Current topics: Biosimilars and the currently marketed "Biopharmaceuticals"

Lecture notes
The slides used for the lectures will be provided online

Literature

Prerequisites / notice
Requirements: Basic knowledge in molecular biology, protein chemistry and analytics. Basic knowledge in pharmacology.

535-0300-00L Molecular Mechanisms of Drug Actions and Targets | W | 1 credit | 1V | V. I. Otto |

Abstract
In the last 10 years, an average of one drug per year was withdrawn from the market. Using selected examples of such drug failures, the course aims at analyzing the present explanations of drug actions as well as the design and predictive power of animal models and clinical trials. In addition, the ethical, societal, and economical expectations in new drugs shall be reflected.

Objective
To develop a critical understanding of the relevance and limitations of the current approaches to explaining and anticipating drug effects. To critically appraise the ethical, societal, economical and political expectations in the development of new drugs.

Content
In December 2006, Pfizer stopped a large phase III study on the use of Torcetrapib for the prevention of atherosclerosis and cardiovascular disease. 800 million $ in development costs and 21 billion $ in stocks were annihilated overnight. The failure of Torcetrapib has pinpointed the limitations of an extremely reductionist view of atherosclerosis and it's prevention by drug therapy. It has also highlighted what high expectations we have in a safe and wide applicability of drugs and of their economical success. Torcetrapib is not a single case. In the last 10 years, on average one drug per year was withdrawn from the market due to lack of efficacy, unexpected side effects or toxicity. This clearly shows that the common investigations and the modern understanding of drug actions are often not sufficient to predict the effects a drug will have in large patient populations. These are the topics of the present course. Using three particularly informative examples of drug failures, the problems encountered and the concepts and informative value of preclinical and clinical studies will be analyzed and discussed. Furthermore, the ethical, societal, economical and political expectations in new drugs shall be reflected.

Lecture notes
Printouts of the slides used for the lectures and literature for reading and discussions will be available online.

Literature
Recommended reading: John Abramson, Overdo$ed America, Harper Perennial, New York 2008

Prerequisites / notice
Requirements: basic knowledge in Medicinal Chemistry and Pharmacology. Ability to read and understand scientific publications in English.

535-0022-00L Computer-Assisted Drug Design | W | 1 credit | 1V | G. Schneider |

Abstract
The lecture series provides an introduction to computer applications in medicinal chemistry. A focus is on molecular representations, property predictions, molecular similarity concepts, virtual screening techniques, and de novo drug design. All theoretical concepts and algorithms presented are illustrated by practical applications and case studies

Objective
The students will learn how computer simulation can be used for drug design and development, understand the theoretical principles of property prediction and computer-generated compound generation, and understand possibilities and limitations of computer-assisted drug design in pharmaceutical chemistry. As a result, they are prepared for professional assessment of computer-assisted drug design studies in medicinal chemistry projects.

Literature
Recommended textbooks:
Successful participation in this course is required for a research project ("Forschungspraktikum") in the CADD group.

851-0180-00L Research Ethics

- Particularly suitable for students of D-BIOL, D-CHAB, D-HEST
- 2 credits
- W
- 2G
- G. Achermann

Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.

Content

I. Ethics & the Process of Ethical Inquiry

- Introduction in Ethics and Research Ethics
  - What is ethics? What ethics is not...;
  - Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
  - The ethics movement in the biological and health sciences;
  - What is research ethics and why is it important?
  - Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
  - Professional codes of conduct: functions and limitations

- Ethical approaches in the conduct of research (Normative Ethics)
  - Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties); consequentialist theories, other theories);
  - The plurality of ethical theories and its consequences;
  - The concept of dignity

- Moral reasoning I: Arguments
  - Why arguments? What is a good argument? The structure of (moral) arguments;
  - Deductive and inductive arguments; Validity and soundness;
  - Assessing moral arguments

- Moral reasoning II: Decision-making
  - How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
  - Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
  - Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

- Integrity in Research & Research Misconduct
  - What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
  - Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
  - The confidant of ETH Zurich

- Data Management
  - Data collection and recordkeeping; Analysis and selection of data;
  - Ownership of data; retention and sharing of data;
  - Falsification and fabrication of data

- Research involving animals
  - The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
  - The 3 R's (replacement, reduction, refinement);
  - Ethical assessment of conflicting issues in animal experimentation;
  - The dignity of animals in the Swiss constitution;

- Research involving human subjects
  - History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
  - Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
  - Clinical trials;
  - Biobanks
  - Ethics Committees / Institutional Review Boards (IRB)

- Authorship & Peer review
  - Criteria for authorship;
  - Plagiarism;
  - Challenges to openness and freedom in scientific publication;
  - Open access
  - Peer review

- Social responsibility
  - What is social responsibility? Social responsibility: whose obligation?
  - Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.
**Research Project**

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<tbody>
<tr>
<td>511-0001-00L</td>
<td>Research Project</td>
<td>O</td>
<td>10</td>
<td>20A</td>
<td>Lecturers</td>
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**Objective**

The Research Project accustoms students to scientific work.

**Content**

Students are accustomed to scientific work and they get to know one specific research field.

Students work on a current field of research.

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**Master Thesis**

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<tr>
<td>511-0002-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>40D</td>
<td>Lecturers</td>
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</tbody>
</table>

**Abstract**

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a subject area of Pharmaceutical Sciences as chosen by the student.

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**Compulsory Electives in Humanities, Social and Political Sciences**

Recommended GESS compulsory elective courses (Type B) for D-CHAB:

- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses
Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>E-</td>
<td>4</td>
<td>9R</td>
<td>M. Kalisch</td>
</tr>
</tbody>
</table>

Abstract

Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R will be a central theme.

Objective

The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content

From “Statistics for research” (online)
- Ch 1: The Role of Statistics
- Ch 2: Populations, Samples, and Probability Distributions
- Ch 3: Binomial Distributions
- Ch 6: Sampling Distribution of Averages
- Ch 7: Normal Distributions
- Ch 8: Student's t Distribution
- Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
- Ch 1: Basics
- Ch 2: The R Environment
- Ch 3: Probability and distributions
- Ch 4: Descriptive statistics and tables
- Ch 5: One- and two-sample tests
- Ch 6: Regression and correlation

Literature

- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471477433; Online ISBN: 9780471477433; DOI: 10.1002/0471477435


Abstract

The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Objective

The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Literature


Topic/Lecturer/Chapter/Pages:

- Analyzing cells & molecules / Gebhard Schertler/ 8: 439-463;
- Membrane structure / Gebhard Schertler/ 10: 565-595;
- Compartment and Sorting/ Ulrike Kutay/ 12: 14-6: 641-694/755-758/782-783/315-320/325 -333/Table 6-2/Figure6-20, 6-21, 6-32, 6-34;
- Intracellular Membrane Traffic/ Ulrike Kutay/13/895-752;
- The Cytoskeleton/ Ulrike Kutay/ 16/889 - 948 (only the essentials);
- Membrane Transport of Small Molecules and the Electrical Properties of Membranes /Sabine Werner/11/597 - 633;
- Mechanisms of Cell Communication / Sabine Werner/15/813-876;
- Cell Junctions and Extracellular Matrix/Ueli Suter / 1035-1081;
- Stem Cells and Tissue Renewal/Ueli Suter /1217-1262;
- Development of Multicellular organisms/ Ernst Hafen/ 21/ 1145-1179 /1184-1198/1198-1213;
- Cell Migration/Joao Matos/951-960;
- Cell Death/Joao Matos/1021-1032;
- Cell Cycle/chromosome segregation/Cell division/Mitosis/Joao Matos/ 963-1018.

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<tr>
<td>535-0135-AAL</td>
<td>Clinical Chemistry II</td>
<td>E- 1 credit  2R</td>
<td>M. Hersberger</td>
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</tbody>
</table>

Abstract

Introduction into fundamentals of laboratory diagnostics and overview of the laboratory parameters concerning inflammation, lipid metabolism, myocardial infarction, diabetes, kidney function, urinary diagnostics, liver function, blood coagulation, blood count, therapeutic drug monitoring and drugs of abuse screening.

Objective

Overview of the possibilities and limitations in clinical laboratory diagnostics. Indications and methods of everyday parameters are known.
Courses outside the curriculum

Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacopeias. Identification, purity testing, stability testing, assays of drugs and drug formulations.


The students know the relevance and the role of quality assurance measures to assure quality, efficacy and safety of drugs. The students know the most important Swiss regulations, including the associated European regulations, which are relevant from a quality assurance point of view and they are able to interpret the content of this regulations.

Eligible for credits and recommended

Identification, purity testing, stability testing, assays of drugs and drug formulations. The students know the relevance and the role of quality assurance measures to assure quality, efficacy and safety of drugs. The students know the most important Swiss regulations, including the associated European regulations, which are relevant from a quality assurance point of view and they are able to interpret the content of this regulations.

Enrolment only for MSc students who need this course as additional admission requirement.

Objective

Introduction to pharmacokinetics; definition of the most important pharmacokinetic parameters and their calculation from clinical data (compartment model, statistical model); kinetics of absorption (absorption profiles); distribution of drugs and role of protein binding; kinetics of elimination: excretion and biotransformation (physiological model); pharmacokinetic profiling of drugs for therapy optimization and for the analysis of the interaction potential; dosage regimen design.

Eligible for credits and recommended

Identification, purity testing, stability testing, assays of drugs and drug formulations. The students know the relevance and the role of quality assurance measures to assure quality, efficacy and safety of drugs. The students know the most important Swiss regulations, including the associated European regulations, which are relevant from a quality assurance point of view and they are able to interpret the content of this regulations.

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.

Abstract

Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.

Introduction into medical laboratory diagnostics: immunochemical methods, diagnostics of inflammation, acute myocardial infarction, lipid metabolism, diabetes, kidney function and urinary diagnostics, blood coagulation, blood count, therapeutic drug monitoring, drugs of abuse screening, common diagnostics of liver diseases, point-of-care diagnostics.

Enrolment only for MSc students who need this course as additional admission requirement.

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Abstract
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<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Micro- and Nanosystems Master

Core Courses

Devices and Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0197-00L</td>
<td>Wearable Systems I</td>
<td>W+</td>
<td>6</td>
<td>4G</td>
<td>G. Tröster, U. Blanke</td>
</tr>
</tbody>
</table>
| Abstract  | Context recognition in mobile communication systems like mobile phone and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning. Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment. 
Objective | Future mobile systems will act as personal and cooperative assistant providing the appropriate information and services. The systems consist of a smart phone which communicates with sensors on-body and in the environment. Context comprises user's behavior, his activities, his local and social environment. |
| Content   | The next generation of mobile communication systems are integrated in our clothes and act as personal and cooperative assistant providing information we need just now (see www.wearable.ethz.ch). Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course. The main topics of the course include: Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, KNN-Methods, Support Vector Machine, Hidden Markov Models, Adaboost), clustering (k-means, dbscan, topic models) Crowdsourcing. The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment. Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects. |
| Literature | Lecture notes: No special prerequisites |
| Lecture notes | Lecture notes for all lessons, assignments and solutions. http://www.ife.ee.ethz.ch/education/wearable_systems_1 |

Analog Integrated Circuits

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0166-00L</td>
<td>Analog Integrated Circuits</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>Q. Huang</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies. Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems. The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.</td>
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<tr>
<td>Objective</td>
<td>Review of bipolar and MOS devices and their small-signal equivalent circuit models: Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits. The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.</td>
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<tr>
<td>Content</td>
<td>Literature will be announced during the lessons. Lecture notes: Handouts of presented slides. No script but an accompanying textbook is recommended.</td>
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Energy Conversion and Quantum Phenomena

Semiconductor Nanostuctures

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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0595-00L</td>
<td>Semiconductor Nanostructures</td>
<td>W+</td>
<td>6</td>
<td>2V+1U</td>
<td>T. Ihn</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.</td>
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<tr>
<td>Objective</td>
<td>At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures: 1. The integer quantum Hall effect 2. Conductance quantization in quantum point contacts 3. the Aharonov-Bohm effect 4. Coulomb blockade in quantum dots</td>
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In addition to the lecture notes, the following supplementary books can be recommended:


**Material, Surfaces and Properties**

**Continuum Mechanics**

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<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0524-00L</td>
<td>Continuum Mechanics I</td>
<td>W</td>
<td>4</td>
<td>2+1U</td>
<td>E. Mazza</td>
</tr>
</tbody>
</table>

**Surfaces, Interfaces and their Applications I**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>327-0505-00L</td>
<td>Surfaces, Interfaces and their Applications I</td>
<td>W</td>
<td>3</td>
<td>2+1U</td>
<td>N. Spencer, M. P. Heuberger, L. Isa</td>
</tr>
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**Modelling and Simulation**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-2037-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
</tr>
</tbody>
</table>
The course will cover the basic principles of wave propagation. It will discuss the fundamental principles used to describe linear and nonlinear wave propagation in continuum and discrete media. Selected recent scientific advancements in the dynamics of periodic media will also be discussed.

Objective

Students learn the basic principles governing the propagation of waves in discrete and continuum solid media. These methods can be used to engineer materials with predefined properties and to design dynamical systems for a variety of engineering applications (e.g., vibration mitigation, impact absorption and sound insulation).

Content

Wave propagation in solids including applications. Phenomenology of wave propagation (plane waves, harmonic waves, dispersion, attenuation, group and phase velocity), transmission and reflection, impact problems, waves in linear elastic media, discrete media, experimental and numerical methods.

Lecture notes

http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

Class notes, handouts

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### Laboratory Course

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0620-00L</td>
<td>Embedded MEMS Lab</td>
<td>W+</td>
<td>5</td>
<td>3P</td>
<td>C. Hierold, S. Blunier, M. Haluska</td>
</tr>
</tbody>
</table>

#### Abstract

This practical course: Students are introduced to the process steps required for the fabrication of MEMS (Micro Electro Mechanical System) and carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report.

#### Objective

Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

#### Content

- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

#### Lecture notes

A document containing theory, background and practical course content is distributed at the first meeting of the course.

#### Literature

The document provides sufficient information for the participants to successfully participate in the course.

#### Prerequisites / notice

Participating students are required to attend all scheduled lectures and meetings of the course.

Participating students are required to provide proof that they have personal accident insurance prior to the start of the laboratory portion of the course.

This master's level course is limited to 15 students per semester for safety and efficiency reasons. If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

- Priority 1: master students of the master's program in "Micro and Nanosystems"
- Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MAVT-tutors Profs Daraio, Dual, Hierold, Koumoutsakos, Nelson, Norris, Park, Poulikakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.
- Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.
- Priority 4: all other students (PhD, bachelor, master) with a background in silicon or Microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.

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### Elective Core Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0525-00L</td>
<td>Wave Propagation in Solids</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>C. Daraio</td>
</tr>
</tbody>
</table>

#### Abstract

The course will cover the basic principles of wave propagation in periodic media. It will discuss the fundamental principles used to describe linear and nonlinear wave propagation in continuum and discrete media. Selected recent scientific advancements in the dynamics of periodic media will also be discussed.

#### Objective

Students learn the basic principles governing the propagation of waves in discrete and continuum solid media. These methods can be used to engineer materials with predefined properties and to design dynamical systems for a variety of engineering applications (e.g., vibration mitigation, impact absorption and sound insulation).

#### Content

Wave propagation in solids including applications. Phenomenology of wave propagation (plane waves, harmonic waves, dispersion, attenuation, group and phase velocity), transmission and reflection, impact problems, waves in linear elastic media, discrete media, experimental and numerical methods.

#### Lecture notes

Handouts

Various books will be recommended pertaining to the topics covered.

- Wave Conversion and Transport in Biosystems
  - Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.

#### Notice

This master's level course is limited to 15 students per semester for safety and efficiency reasons. If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

- Priority 1: master students of the master's program in "Micro and Nanosystems"
- Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MAVT-tutors Profs Daraio, Dual, Hierold, Koumoutsakos, Nelson, Norris, Park, Poulikakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.
- Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.
- Priority 4: all other students (PhD, bachelor, master) with a background in silicon or Microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.
Familiarize students with basic science and engineering principles governing the nano domain. From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the material is distributed during the lecture. The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where students work out the links between topics from atoms to molecules to condensed matter. Physical and chemical methods important for research in surface science, material science, and catalysis are considered and their application is demonstrated on practical examples. The course addresses basic science and engineering principles governing the nano domain. The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where students work out the links between topics that are traditionally taught separately.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.

Familiarize students with basic science and engineering principles governing the nano domain. The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

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Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.

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Familiarize students with basic science and engineering principles governing the nano domain. The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled.
Content

Process economic evaluation: equipment sizing and costing, time value of money, cash flow calculations.
Batch Processes: scheduling, sizing and inventories.
Detailed Process Design: unit operation models, flash solution algorithms (different iterative methods, inside-out method), sequencing of nonideal distillation columns, networks of chemical reactors.

Lecture notes
no script

Literature

Prerequisites / notice
Prerequisite: Thermal Unit Operations

752-3103-00L Food Rheology I W 3 credits 2V P. A. Fischer

Abstract
Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloidal systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are introduced and discussed.

Objective
The concept of rheological constitutive equations and the application to different material classes. The course provides an introduction on the link between flow and structural properties of flowing material. Rheometrical techniques and appropriate measuring protocols for the characterization of complex fluids will be discussed.

Content
Lectures will be given on general introduction (4h), fluid dynamics (4h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h).

Lecture notes
Notes will be handed out during the lectures.

Lecture notes
Provided in the lecture notes.

227-0157-00L Semiconductor Devices: Physical Bases and Simulation W 4 credits 3G A. Schenk

Abstract
The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductors and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

Objective
The course aims at understanding the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided.

Content
The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions. The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

Lecture notes

Prerequisites / notice

227-0225-00L Linear System Theory W 6 credits 5G J. Lygeros, M. Kamgarpour

Abstract
The course is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

Objective
By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.

Content
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

Lecture notes
The script (in book style) is sufficient. Further reading will be recommended in the lecture.

Prerequisites / notice
Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.

227-0377-00L Physics of Failure and Failure Analysis of Electronic Devices and Equipment W 3 credits 2V U. Sennhauser

Abstract
Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

Objective
Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

Content
Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of devices and systems; application in circuit design and reliability analysis

Lecture notes
Comprehensive copy of transparencies

151-0593-00L Embedded Control Systems W 4 credits 6G J. S. Freudenberg, M. Schmid Daners

Abstract
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

Objective
Familiarize students with main architectural principles and concepts of embedded control systems.
This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: schmid@idsc.mavt.ethz.ch).

After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

**151-0235-00L Thermodynamics of Novel Energy Conversion**

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<th>4 credits</th>
<th>D. Poulikakos</th>
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**227-0145-00L Solid State Electronics**

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**151-0621-00L Microsystems Technology**

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<th>Content</th>
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**402-0811-00L Programming Techniques for Scientific Simulations I**

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<th>Content</th>
<th>4G</th>
<th>M. Troyer</th>
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**415-0911-00L Introduction to Plasmonics**

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<tr>
<th>Content</th>
<th>2V+1U</th>
<th>D. J. Norris</th>
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Objective
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

Content
Fundamentals of Plasmonics
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

Lecture notes
Class notes and handouts

Literature

Prerequisites / notice
Physics I, Physics II

151-0642-00L
Seminar on Micro and Nanosystems
Z 0 credits 1S J. Hierold

Abstract
Scientific presentations from the field of Micro- and Nanosystems

Objective
In particular, the seminar addresses students, who are interested in scientific work in the field of Micro- and Nanosystem technologies, or who have started already with it. Respectively, current examples in the research will be discussed.

Content
Current themes in the field of Micro- and Nanosystem technologies using the examples of intern and external research groups, as well as ongoing themes of study-, diploma- and doctoral thesis will be introduced and discussed. The scope of the seminar is broadened by occasional guest speakers.

151-0511-00L
Mechanics of Nano- and Micro-Materials
W 4 credits 2V+1U C. Daraio

Abstract
The course provides an introduction to the mechanics of nano- and micro-materials and devices, in the quasistatic and dynamic domains. It reviews scale effects in materials, devices, and systems and the interplay of forces and microscale contacts. Recent applications of nano- and micro-materials in engineering systems will be discussed.

Objective
Learn the fundamental mechanical properties of nano- and micro-system. Understand the effects of scales on the response of materials. Explore applications and devices exploiting the response of materials at small scales.

Content
follows soon

Lecture notes
Slides and notes from the course will be provided.

Literature
Relevant articles and reading materials will be provided. Various books will be recommended pertaining to the topics covered.

Prerequisites / notice
Mechanics I, II, III

227-0663-00L
Nano-Optics
W 6 credits 2V+2U L. Novotny

Abstract
Nano-Optics is the study of optical phenomena and techniques on the nanometer scale. It is an emerging field of study motivated by the rapid advance of nanoscience and technology. It embraces topics such as plasmonics, optical antennas, optical trapping and manipulation, and high-resolution imaging and spectroscopy.

Objective
Understanding concepts of light localization and light-matter interactions on the nanoscale.

Content
Starting with an angular spectrum representation of optical fields the role of inhomogeneous evanescent fields is discussed. Among the topics are: theory of strongly focused light, point spread functions, resolution criteria, confocal microscopy, and near-field optical microscopy. Further topics are: optical interactions between nanoparticles, atomic decay rates in inhomogeneous environments, single molecule spectroscopy, light forces and optical trapping, photonic bandgap materials, and theoretical methods in nano-optics.

Prerequisites / notice
- Electrodynamics (or equivalent)
- Physics II

151-0104-00L
Uncertainty Quantification for Engineering & Life Sciences
W 4 credits 3G J. Beck, P. Koumoutsakos

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

227-0468-00L
Analog Signal Processing and Filtering
W 6 credits 2V+2U H. Schmid

Suitable for Master Students as well as Doctoral Students.
This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers.

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.

At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.

Details: https://people.ee.ethz.ch/~haschmid/asfwiki/

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.  

Prerequisites: Recommended (but not required): Stochastic models and signal processing, Communication Electronics, Analog Integrated Circuits, Transmission Lines and Filters.

Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria ...) and of the main properties of linear systems is necessary.

### Multidisciplinary Courses

The students are free to choose individually from the entire course offer of ETH Zurich, ETH Lausanne and the Universities of Zurich and St. Gallen.

### Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MAVT.

- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses ETH/UZH

### Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1007-00L</td>
<td>Semester Project Micro- and Nanosystems Only for Micro- and Nanosystems MSc.</td>
<td>O</td>
<td>8</td>
<td>17A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

The subject of the Semester Project and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

### Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1013-00L</td>
<td>Industrial Internship Micro and Nanosystems</td>
<td>O</td>
<td>8</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

The main objective of the 12-week internship is to expose master's students to the industrial work environment.

### Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
Only students who fulfill the following criteria are allowed to begin with their Master Thesis:

a. Successful completion of the Bachelor programme
b. Any additional requirements for admission to the degree programme have been fulfilled
c. Have achieved at least 32 credits in the category "Core Courses"
c. Successful completion of the Semester Project (the corresponding credits have been acquired)

The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

To choose an adjunct professor of D-MAVT as a supervisor (http://www.mavt.ethz.ch/people/adjunct/index), please contact the Student Administration Office of D-MAVT.

Abstract

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.
Exchange Students

Courses for Exchange Students

Prepare a study plan
In case the course catalogue of the upcoming semester is not available yet, please expect it to be like the year before.

You can study at ETH Zurich as an exchange student for 1 or 2 semesters, starting in the autumn or in the spring semester. Exchange students may choose courses from different curricula and years, provided that at least two thirds of all courses are taken in the ETH Zurich department they are registered in. Please be sure to coordinate your schedule with your home university.

Exam sessions and End-of-semester examinations
Like all ETH Zurich students, exchange students are obliged to sit their exams during the official examination periods. Students are requested to be present at ETH Zurich during these periods. You are therefore expected to plan your studies, internships, jobs, and financial means accordingly.

by individual arrangement

D-ITET (Exchange Students)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1501-00L</td>
<td>Master's Thesis</td>
<td>W</td>
<td>30 credits</td>
<td>68D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Admission only if all of the following apply:

a) bachelor program successfully completed;
b) acquired (if applicable) all credits from additional requirements for admission to master program;
c) successfully completed both semester projects.

Note: the conditions above are not applicable to incoming exchange students.

Registration in mystudies required!

Abstract
The Master Program finishes with a 6-months Master Thesis which is directed by a Professor of the Department or a Professor of another Department who is associated with the D-ITET. Students gain the ability to conduct independent scientific research on a specific research problem.

Objective
see above

Semester Project

Only for Biomedical Engineering MSc Programme Regulations 2013 (i.e. students having started the MSc BME in or after autumn 2013).

Please fill in the following form before registering:
http://www.ee.ethz.ch/bme_project_registration.

Abstract
The semester project is designed to train the students in solving specific biomedical engineering problems. This project uses the technical and social skills acquired during the master's program. The semester project is advised by a professor.

Objective
see above

D-MAVT (Exchange Students)

Nuclear Engineering MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1009-00L</td>
<td>Master's Thesis Nuclear Engineering</td>
<td>W</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their Master Thesis:

a. Successful completion of the Bachelor programme
b. Any additional requirements for admission to the degree programme have been fulfilled
c. Have achieved a total of at least 72 credits in the categories "Core Subjects" and "Electives"
d. Successful completion of the Semester Project (the corresponding credits have been acquired)

The supervisor of the Master Thesis and the choice of the supervisor (ETH or EPFL professor) are to be approved in advance by the tutor.

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Mechanical Engineering MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1001-00L</td>
<td>Master's Thesis Mechanical Engineering</td>
<td>W</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their Master's Thesis:

a. Successful completion of the Bachelor's programme
b. Any additional requirements for admission to the degree programme have been fulfilled
c. Successful completion of the Semester Project and Industrial Internship (the corresponding credits have been acquired)

d. The subject of the Master's Thesis and the choice of the supervisor (ETH professor/titular professor) are to be approved by the tutor.

To choose a titular professor of D-MAVT as a supervisor (https://www.mavt.ethz.ch/the-department/people/titular-professors.html), please contact

Abstract

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Micro- and Nanosystems MSc

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
151-1006-00L | Master's Thesis Micro- and Nanosystems | W | 30 credits | 64D | Professors

Only students who fulfill the following criteria are allowed to begin with their Master Thesis:
- Successful completion of the Bachelor programme
- Any additional requirements for admission to the degree programme have been fulfilled
- Have achieved at least 32 credits in the category "Core Courses"
- Successful completion of the Semester Project (the corresponding credits have been acquired)

The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor. To choose an adjunct professor of D-MAVT as a supervisor (http://www.mavt.ethz.ch/people/adjunct/index), please contact the Student Administration Office of D-MAVT.

Robotics, Systems and Control MSc

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
151-1016-00L | Master's Thesis Robotics, Systems and Control | W | 30 credits | 64D | Professors

Only students who fulfill the following criteria are allowed to begin with their Master Thesis:
- Successful completion of the Bachelor programme
- Any additional requirements for admission to the degree programme have been fulfilled
- Only two courses can be pending in the category "Core Courses"
- Successful completion of the Semester Project (the corresponding credits have been acquired)

The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor. To choose an adjunct professor of D-MAVT as a supervisor (http://www.mavt.ethz.ch/people/adjunct/index), please contact the Student Administration Office of D-MAVT.

Process Engineering MSc

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
151-1005-00L | Master's Thesis Process Engineering | W | 30 credits | 64D | Professors

Only students who fulfill the following criteria are allowed to begin with their Master Thesis:
- Successful completion of the Bachelor programme
- Any additional requirements for admission to the degree programme have been fulfilled
- Successful completion of the Semester Project and Industrial Internship (the corresponding credits have been acquired)

The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor. To choose an adjunct professor of D-MAVT as a supervisor (http://www.mavt.ethz.ch/people/adjunct/index), please contact the Student Administration Office of D-MAVT.

D-MTEC (Exchange Students)

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.
Only students who fulfill the following criteria are allowed to begin with their master thesis:
a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme;
c. internship fulfilled

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

Objective
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

Exchange Students - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Neural Systems and Computation Master

Core Courses

Compulsory Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1045-00L</td>
<td>Readings in Neuroinformatics</td>
<td>O</td>
<td>3</td>
<td>1S</td>
<td>G. Indiveri, M. Cook, D. Kiper</td>
</tr>
<tr>
<td>Abstract</td>
<td>Thirteen major areas of research have been selected, which</td>
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<tr>
<td></td>
<td>cover the key concepts that have led to our current ideas</td>
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<td></td>
<td>of how the nervous system is built and functions. We will</td>
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<td></td>
<td>read both original papers and explore the concepts and the</td>
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<tr>
<td></td>
<td><code>sociology of science</code>, the pursuit of basic science</td>
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<tr>
<td></td>
<td>questions over a century of research.`</td>
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</tr>
</tbody>
</table>

Objective

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else's digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and linked together with related findings from many different scientists, generate the current views of mechanism and structure of the nervous system.

To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. Each week the course members will be given original papers to read for homework, they will have to write a short abstract for each paper. We will then meet weekly with the course leader (KACM) and an assistant for an hour-or-so long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will be in the form of a written exam in which the students will be given a paper and asked to write a short abstract of the contents.

Content

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

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227-1039-00L

Basics of Instrumentation, Measurement, and Analysis (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: INI502

Objective

The goal of Part I is to provide a general introduction to the signal acquisition process. Students are familiarized with basic lab equipment such as oscilloscopes, function generators, and data acquisition devices. Different electrical signals are generated, visualized, filtered, digitized, and analyzed using Matlab (Mathworks Inc.) or Labview (National Instruments).

Prerequisites / notice

For each part, students must hand in a written report and present a live demonstration of their measurement setup to the respective supervisor. The supervisor of Part I is the teaching assistant, and the supervisor of Part II is task specific. Admission to Part II is conditional on completion of Part I (report + live demonstration).

Reports must contain detailed descriptions of the measurement goal, the measurement procedure, and the measurement outcome. Either confidence or significance of measurements must be provided. Acquisition and analysis software must be documented.

227-1031-00L

Journal Club

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: INI702

Objective

The Neuroinformatics Journal club aims to train students to present cutting-edge research clearly and efficiently. It leads students to learn about current topics in neurosciences and neuroinformatics, to search the relevant literature and to critically and scholarly appraise published papers. The students learn to present complex concepts and answer critical questions.

Content

Relevant current papers in neurosciences and neuroinformatics are covered.

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 1091 of 1432
Elective Core Courses

Systems Neurosciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1051-00L</td>
<td>Introduction to Systems Neuroscience</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>D. Kiper</td>
</tr>
</tbody>
</table>

Abstract
Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Objective
This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions.

Content
This course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Lecture notes
None

Literature
“Principles of Neural Science", Kandel, Schwartz, and Jessel

Introduction to Neuroinformatics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6 credits</td>
<td>3V</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
</tr>
</tbody>
</table>

Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, math, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

Methods & Models for fMRI Data Analysis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0969-00L</td>
<td>Methods &amp; Models for fMRI Data Analysis</td>
<td>W</td>
<td>6 credits</td>
<td>3V</td>
<td>K. E. Stephan</td>
</tr>
</tbody>
</table>

Abstract
This course teaches methods and models for fMRI data analysis, covering all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, statistical inference, multiple comparison corrections, event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data.

Objective
To obtain in-depth knowledge of the theoretical foundations of SPM and DCM and of their application to empirical fMRI data.

Content
This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in psychiatry, neurology and neuroeconomics.

Computational Sciences

No course offerings in this semester

Neuromorphic Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+3U</td>
<td>T. Delbrück, G. Indiveri, S.C. Liu</td>
</tr>
</tbody>
</table>

Abstract
This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective
Understanding the characteristics of neuromorphic circuit elements.

Content
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulation of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogously to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Literature
S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites / notice
Prerequisites: Background in basics of semiconductor physics helpful, but not required.
## Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
<td></td>
<td>4</td>
<td>3G+2U</td>
<td>V. C. Gradinaru</td>
</tr>
<tr>
<td>Abstract</td>
<td>Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.</td>
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<tr>
<td>Objective</td>
<td>Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte</td>
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<tr>
<td>Lecture notes</td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002</td>
<td></td>
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</tr>
<tr>
<td>401-0603-00L</td>
<td>Stochastics (Probability and Statistics)</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>J. Teichmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of the basic principles of probability and statistics.</td>
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<tr>
<td>Content</td>
<td>Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes</td>
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</tr>
<tr>
<td>Literature</td>
<td>Lecture notes</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>401-0613-00L</td>
<td>Probability and Statistics</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>P. Embrechts</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic concepts from probability and statistics:</td>
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<td></td>
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<tr>
<td></td>
<td>- introduction to probability theory</td>
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<tr>
<td></td>
<td>- short introduction to basic concepts and methods from statistics</td>
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<td></td>
<td>- probabilistic thinking and stochastic modelling</td>
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<td></td>
<td>- ability to understand the covered methods from probability theory and to apply them in other contexts</td>
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<td></td>
<td>- ability to perform basic statistical tests and to interpret the results</td>
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<tr>
<td>Objective</td>
<td>The conceptual goals are</td>
<td></td>
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<tr>
<td></td>
<td>- the laws of randomness and probabilistic thinking (thinking in probabilities)</td>
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<td></td>
<td>- understanding and intuition for stochastic modelling</td>
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<tr>
<td></td>
<td>- simple and basic methods from statistics</td>
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<tr>
<td>Content</td>
<td>The contents of the course encompasses</td>
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<tr>
<td></td>
<td>- an introduction to probability theory: basic concepts (probability space, probability measure), independence, random variables, discrete and continuous distributions, conditional probability, expectation and variance, limit theorems</td>
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<tr>
<td></td>
<td>- methods from statistics: parameter estimation, maximum likelihood and moment methods, tests, confidence intervals</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes for the course (in German) will be made available electronically at the beginning of the course.</td>
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</tbody>
</table>

### Auditorium Informatics

<table>
<thead>
<tr>
<th>Number</th>
<th>Auditory Informatics</th>
<th>W</th>
<th>2</th>
<th>1S</th>
<th>R. Stoop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Invited talks on current research from the following areas: Auditory information processing, auditory sensors (biological and electrical), coding of information, perception, scene-segmentation.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Exchange with researchers in the domain of auditory informatics. Preparing and giving a presentation on a suitable topic in front of a scientific audience.</td>
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<tr>
<td>Content</td>
<td>The semester program is available under: <a href="http://stoop.ini.uzh.ch/teaching/seminar-on-auditory-informatics">http://stoop.ini.uzh.ch/teaching/seminar-on-auditory-informatics</a></td>
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<tr>
<td>Prerequisites / notice</td>
<td>On request the &quot;Lehrsprache&quot; may be changed to German.</td>
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</table>

### Dynamical Systems in Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Dynamical Systems in Biology</th>
<th>W</th>
<th>6</th>
<th>2V+1U</th>
<th>R. Stoop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This lecture uses the concepts from dynamical systems (Course: &quot;Computable Chaos in Dynamical Systems&quot;) for the description of salient phenomena in complex examples from population dynamics, neuroinformatics and system biology. A particular focus is on the concept of limit cycle solutions and their coupling.</td>
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<tr>
<td>Objective</td>
<td>Applying concepts from nonlinear dynamics to biological systems. Combining theoretical modeling with supporting computer simulations.</td>
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</tbody>
</table>

### Programming Techniques for Scientific Simulations I

<table>
<thead>
<tr>
<th>Number</th>
<th>Programming Techniques for Scientific Simulations I</th>
<th>W</th>
<th>5</th>
<th>4G</th>
<th>M. Troyer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained.</td>
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</tbody>
</table>

### Introduction to Computational Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Introduction to Computational Physics</th>
<th>W</th>
<th>8</th>
<th>2V+2U</th>
<th>H. J. Herrmann</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Lecture and exercise lessons in english, exams in German or in English</td>
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</tbody>
</table>

### Electron Microscopy in Material Science

Content
This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and geological chemistry will be reported.

Lecture notes
English

Literature

<table>
<thead>
<tr>
<th>227-0147-00L</th>
<th>VLSI II: Design of Very Large Scale Integration</th>
<th>W</th>
<th>7 credits</th>
<th>5G</th>
<th>H. Kaeslin, N. Felber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuits</td>
<td>Abstract</td>
<td>This second course in our VLSI series is concerned with how to turn digital netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects (clock skew, metastability, ground bounce, IR-drop, electromigration, ESD, latchup). Economic aspects and management issues of VLSI projects are also addressed.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Objective</td>
<td>Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Prerequisites</td>
<td>The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Exercises</td>
<td>Highlight</td>
<td>Limitations of functional design verification, design for test.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Highlights</td>
<td>Prerequisites</td>
<td>Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.</td>
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</tr>
<tr>
<td>Further details</td>
<td>Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.</td>
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<tr>
<td><a href="http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html">http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html</a></td>
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<table>
<thead>
<tr>
<th>402-0341-00L</th>
<th>Medical Physics I</th>
<th>W</th>
<th>6 credits</th>
<th>2V+1U</th>
<th>P. Manser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Objective</td>
<td>Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Content</td>
<td>Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.</td>
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</tr>
<tr>
<td>Content</td>
<td>Lecture notes</td>
<td>The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the excercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.</td>
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<tr>
<td>Lecture notes</td>
<td>Further details</td>
<td>A script will be provided.</td>
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</table>

<table>
<thead>
<tr>
<th>227-1047-00L</th>
<th>Consciousness: From Philosophy to Neuroscience</th>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>D. Kiper, A. Gamma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Objective</td>
<td>This seminar reviews the philosophical and phenomenological as well as the neurobiological aspects of consciousness. The subjective features of consciousness are explored, and modern research into its neural substrate, particularly in the visual domain, is explained. Emphasis is placed on students developing their own thinking through a discussion-centered course structure.</td>
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<tr>
<td>Objective</td>
<td>Content</td>
<td>The course's goal is to give an overview of the contemporary state of consciousness research, with emphasis on the contributions brought by modern cognitive neuroscience. We aim to clarify concepts, explain their philosophical and scientific backgrounds, and to present experimental protocols that shed light on a variety of consciousness related issues.</td>
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<tr>
<td>Content</td>
<td>Further details</td>
<td>The course includes discussions of scientific as well as philosophical articles. We review current schools of thought, models of consciousness, and proposals for the neural correlate of consciousness (NCC).</td>
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</tbody>
</table>

We display articles pertaining to the issues we cover in the class on the course's webpage. Since we are all experts on consciousness, we expect active participation and discussions!

**402-0674-00L**  
**Abstract**  
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

**Objective**  
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour. As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxide and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure’s shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetry and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue’s anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

**252-0523-00L**  
**Computational Biology**  
Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

**Objective**  
Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

**Content**  
This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

**227-0427-00L**  
**Signal and Information Processing: Modeling, Filtering, Learning**  
Fundamentals in signal processing, detection/estimation, and machine learning.

**Abstract**  
I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparseness.  

**Objective**  
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

**Content**  

**Prerequisites**  
- local bachelor’s course “Discrete-Time and Statistical Signal Processing” (5. Sem.)  
- others: solid basics in linear algebra and probability theory

**252-0535-00L**  
**Machine Learning**  
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

**Objective**  
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.
Abstract
Usually a student selects the topic of a Master Short Project in consultation with his or her mentor.

Objective
see above

227-1036-02L NSC Master Short Project II
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: INI506

Objective
see above

Neural Systems and Computation Master - Key for Type

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

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Core Courses

#### 1. Semester (EPFL)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-2011-00L</td>
<td>Neutronics (EPFL)</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>external organisers</td>
</tr>
</tbody>
</table>

**Abstract**
In this course, one acquires an understanding of the basic neutronics interactions occurring in a nuclear fission reactor and, as such, the conditions for establishing and controlling a nuclear chain reaction.

**Objective**
By the end of the course, the student must be able to:
- Elaborate on neutron diffusion equation
- Systematize nuclear reaction cross sections
- Formulate approximations to solving the diffusion equation for simple systems

**Content**
- Brief review of nuclear physics
- Historical: Constitution of the nucleus and discovery of the neutron
- Nuclear reactions and radioactivity - Cross sections - Differences between fusion and fission.
- Nuclear fission
- Characteristics - Nuclear fuel - Introductory elements of neutronics.
- Fissile and fertile materials - Breeding.
- Neutron diffusion and slowing down
- Monoenergetic neutrons - Angular and scalar flux
- Diffusion theory as simplified case of transport theory - Neutron slowing down through elastic scattering.
- Multiplying media (reactors)
- Multiplication factors - Criticality condition in simple cases.
- Reactor kinetics
- Point reactor model: prompt and delayed transients - Practical applications.
- Reactivity variations and control
- Short, medium and long term reactivity changes? Different means of control.

**Literature**
Distributed documents, recommended book chapters

**Prerequisites / notice**
Prerequisite for: Reactor Experiments

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-2013-00L</td>
<td>Reactor Experiments (EPFL)</td>
<td>O</td>
<td>4 credits</td>
<td>5U</td>
<td>external organisers</td>
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</tbody>
</table>

**Abstract**
To gain hands-on experience in the conduction of nuclear radiation measurements, as also in the execution and analysis of reactor physics experiments using the CROCUS reactor.

**Objective**
To gain hands-on experience in the conduction of nuclear radiation measurements, as also in the execution and analysis of reactor physics experiments using the CROCUS reactor.

**Content**
- Radiation detector systems, alpha and beta particles
- Radiation detector systems, gamma spectroscopy
- Introduction to neutron detectors (He-3, BF3)
- Slowing-down area (Fermi age) of Pu-Be neutrons in H2O
- Approach-to-critical experiments
- Buckling measurements
- Reactor power calibration
- Control rod calibration

**Literature**
Distributed documents, recommended book chapters

**Prerequisites / notice**
Prerequisite for: Special Topics in Reactor Physics (2nd sem.)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-2015-00L</td>
<td>Reactor Technology (EPFL)</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>H.M. Prasser, external organisers</td>
</tr>
</tbody>
</table>

**Abstract**
This course provides an overview of microfabrication processes used to produce micro-scale robots and will cover topics related to microactuators, microsensors, and modeling at these scales. The course will also investigate micromanipulation technologies, incl. the assembly of micron-sized parts, the manipulation of biological cells, and the types of robots used to perform these tasks.

**Objective**
To comprehend (particularly in the context of light water reactors) the basic heat removal phenomena in a reactor core, identify the technological limits for heat generation from the viewpoints of fuel, cladding and coolant, and be introduced to optimization principles in reactor thermal design.
Abstract
To understand the basic principles governing the advanced energy conversion systems and the perspective for technological progress. To present the characteristics of the main fossil and renewable energy systems from a resource and production technology view. Learning to assess the globally and locally available resources of such energies and be able to dimension roughly the installation required.

Objective
To understand the basic principles governing the advanced energy conversion systems and the perspective for technological progress. To present the essential characteristics of the main fossil and renewable energy systems from a resource and production technology viewpoint. The students will learn to assess the globally and locally available resources of such fossil or renewable energies and be able to make a rough dimensioning of the installations that will use them.

Content
- Overview of fossil and renewable energy resource characteristics
- Reminder of Thermodynamic Laws and exergy theory
- Vapour and gas cycles, combined cycles. Natural gas, coal and nuclear power plants
- Fuel cell principles and technologies. Hybrid fuel cell - turbine cycles
- Technologies of heat pumps (compression, absorption, magnetic) and Organic Rankine Cycles (ORC). Co- and tri-generation
- Biomass technologies for both fuel (liquid or gas) or electricity
- Solar energy resources
- Solar-thermal and photovoltaic systems
- Hydraulic resources
- Hydraulic turbines and schemes
- Wind energy resources
- Wind turbines
- Other renewable technologies

Literature
- Bibliographie: Notes of the lectures;

Prerequisites / notice
Required prior knowledge: Neutronics
Prerequisite for: Nuclear Safety (2nd sem.)
Prerequisites / notice
Prérequis: Mécanique des milieux continus; Introduction aux turbomachines. Préparation pour: Choix des équipements hydrauliques; Projets et travail pratique de Master

151-2023-00L Nuclear Fusion and Plasma Physics (EPFL) W 4 credits 4G external organisers
No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL.
Objective
Achieve basic understanding of plasma physics concepts for fusion energy, and of basic principles of fusion reactors
Content
1) Basics of thermonuclear fusion
2) The plasma state and its collective effects
3) Charged particle motion and collisional effects
4) Fluid description of a plasma
5) Plasma equilibrium and stability
6) Magnetic confinement: Tokamak and Stellarator
7) Waves in plasma
8) Wave-particle interactions
9) Heating and non inductive current drive by radio frequency waves
10) Heating and non inductive current drive by neutral particle beams
11) Material science and technology: Low and high Temperature superconductor - Properties of material under irradiation
12) Some nuclear aspects of a fusion reactor: Tritium production
13) Licensing a fusion reactor: safety, nuclear waste
14) Inertial confinement
Literature
Prerequisites / notice
Required prior knowledge:
Basic knowledge of electricity and magnetism, and of simple concepts of fluids

151-2025-00L Introduction to Particle Accelerators (EPFL) W 4 credits 4G external organisers
No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL.
Abstract
The course presents basic physics ideas underlying the workings of modern accelerators. We will examine key features and limitations of these machines as used in accelerator driven sciences like high energy physics, materials and life sciences.
Objective
By the end of the course, the student must be able to:
- Design basic linear and non-linear charged particles optics
- Elaborate basic ideas of physics of accelerators
- Use a computer code for optics design
- Optimize accelerator design for a given application
- Estimate main beam parameters of a given accelerator
Content
Overview, history and fundamentals
Transverse particle dynamics (linear and nonlinear)
Linear accelerators
Circular accelerators
Acceleration and RF-technology
Beam diagnostics
Accelerator magnets
Injection and extraction systems
Synchrotron radiation
Literature
Recommended during the course
Prerequisites / notice
Prérequis: Notion de relativité restreinte et d'électrodynamique

151-2041-00L Medical Radiation Physics (EPFL) W 4 credits 3G external organisers
No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL.
Abstract
This course covers the physical principles underlying medical imaging using ionizing radiation (radiography, fluoroscopy, CT, SPECT, PET). The focus is not only on risk and close to the patient and staff, but also on an objective description of the image quality.
Content
Physics of radiography: X-ray production, Radiation-patient interaction, Image detection and display
Image quality: Wagner's taxonomy, MTF, NPS, contrast, SNR, DQE, NEQ, CNR
Dose to the patient: External irradiation, Internal contamination, compartmental models
Physics of computer tomography (CT)
Risk and radiation: Rational risk and state of our knowledge, Psychological aspects, Ethics and communication
Physics of single-photon emission computed tomography (SPECT)
Physics of mammography
Receiver operating characteristics (ROC) and hypothesis testing: Link between medical diagnostic and statistical hypothesis testing, Sensitivity, specificity, prevalence, predictive values
Physics of radioscopy
Model observers in medical imaging: Human visual characteristics and their quantification, Bayesian cost and Ideal model observer, Anthropomorphic model observers, Detection experiments (rating, M-AFC, yes-no)
Physics of positron emission tomography (PET)
Physics of resonance magnetic imaging

151-2043-00L Radiation Protection and Radiation Applications (EPFL) O 4 credits 3G external organisers
No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL.
Abstract
This course covers the physical principles underlying medical imaging using ionizing radiation (radiography, fluoroscopy, CT, SPECT, PET). The focus is not only on risk and close to the patient and staff, but also on an objective description of the image quality.
Content
Physics of radiography: X-ray production, Radiation-patient interaction, Image detection and display
Image quality: Wagner's taxonomy, MTF, NPS, contrast, SNR, DQE, NEQ, CNR
Dose to the patient: External irradiation, Internal contamination, compartmental models
Physics of computer tomography (CT)
Risk and radiation: Rational risk and state of our knowledge, Psychological aspects, Ethics and communication
Physics of single-photon emission computed tomography (SPECT)
Physics of mammography
Receiver operating characteristics (ROC) and hypothesis testing: Link between medical diagnostic and statistical hypothesis testing, Sensitivity, specificity, prevalence, predictive values
Physics of radioscopy
Model observers in medical imaging: Human visual characteristics and their quantification, Bayesian cost and Ideal model observer, Anthropomorphic model observers, Detection experiments (rating, M-AFC, yes-no)
Physics of positron emission tomography (PET)
Physics of resonance magnetic imaging
The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Advanced Topics in Nuclear Reactor Materials.

**Title**

Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related

ECTS

Lecturers

3G

Uncertainty Quantification for Engineering & Life

Topics that will be covered include: Uncertainty quantification under

The course deals with the important challenges for materials (structural and fuel) for current and advanced nuclear power plants.

, H. Ferroukhi, further

To acquire hands-on experience with the running of large computer codes in relation to the static analysis of nuclear reactor cores and the multi-physics simulation of nuclear power plant (NPP) dynamic behaviour.

Objective

By the end of the course, the student must be able to:

- Explain the basic physics principles that underpin radiotherapy, e.g. types of radiation, atomic structure, etc.
- Explain the interaction mechanisms of ionizing radiation at keV and MeV energies with matter.
- Explain the principles of radiation dosimetry.
- Explain the principles of therapeutic radiation physics including X-rays, electron beam physics, radioactive sources, use of unsealed sources and Brachytherapy.
- Describe how to use radiotherapy equipment both for tumour localisation, planning and treatment.
- Define quality assurance and quality control, in the context of radiotherapy and the legal requirements.
- Explain the principles and practice of radiation protection, dose limits, screening and protection mechanisms.
- Explain the use of radiation in industrial and research applications.

Content

Basics: radiation sources and interaction with matter, radioisotope production using reactors and accelerators, radiation protection and shielding.

Medical applications: diagnostic tools, radiopharmaceuticals, cancer treatment methodologies such as brachytherapy, neutron capture therapy and proton therapy.

Industrial applications: radiation gauges, radiochemistry, tracer techniques, radioisotope batteries, sterilization, etc.

Applications in research: dating by nuclear methods, applications in environmental and life sciences, etc.

**3. Semester**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Beck, P. Koumoutsakos</td>
</tr>
</tbody>
</table>

Abstract

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective

The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice

Fundamentals of Probability, Fundamentals of Computational Modeling

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0150-00L</td>
<td>Advanced Topics in Nuclear Reactor Materials</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. A. Pouchon, P. J.P. Spätzig, M. Streit</td>
</tr>
</tbody>
</table>

Abstract

The course deals with the important challenges for materials (structural and fuel) for current and advanced nuclear power plants.

Objective

The behaviour of materials in nuclear reactors determines the reliability and safety of nuclear power plants (NPPs). Life extension and the understanding of fuel behavior under high burn-up conditions is of central importance for current-day NPPs. Advanced future systems (fission and fusion) need materials meeting additional challenges such as high temperatures and/or high doses.

The course will highlight the above needs from different points of view. Experimental methods for the control and analysis of nuclear components and materials in operating NPPs will be presented. Advanced analytical and modeling tools will be introduced for characterization and understanding of irradiation damage, creep, environment effects, etc. Insights acquired from recent experimental programs into high burnup fuel behavior under hypothetical accident conditions (RIA, LOCA) will be presented. Materials for advanced future nuclear plants will be discussed.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-2037-00L</td>
<td>Nuclear Computations Lab</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>A. Pautz, H. Ferroukhi, further lecturers</td>
</tr>
</tbody>
</table>

Abstract

To acquire hands-on experience with the running of large computer codes in relation to the static analysis of nuclear reactor cores and the multi-physics simulation of nuclear power plant (NPP) dynamic behaviour.

Objective

To acquire hands-on experience with the running of large computer codes in relation to the static analysis of nuclear reactor cores and the multi-physics simulation of nuclear power plant (NPP) dynamic behaviour.

Content

- Lattice (assembly) calculations
- Thermal-hydraulic analysis
- Reactor core analysis
- Multi-physics core dynamics calculations
- Best-estimate NPP transient analysis

Literature

Distributed documents, recommended book chapters

Prerequisites / notice

Required prior knowledge: Special Topics in Reactor Physics, Nuclear Safety
151-2039-00L Beyond-Design-Basis Safety O 3 credits 2V H.M. Prasser, J. Birchley, L. Fernandez Moguel, B. Jäckel, T. Lind

Abstract Comprehensive knowledge is provided on the phenomena during a Beyond Design Bases Accident (BDBA) in a Nuclear Power Plants (NPP), on their modeling as well as on countermeasures taken against radioactive releases into the environment, both by Severe Accident Management Guidelines (SAMG), together with technical backfilling measures in existing plants and an extended design of new NPP.

Objective Deep understanding of the processes associated with core degradation and fuel melting in case of sustained lack of Core Cooling, potential threats to the containment integrity, release and transport of active and inactive materials, the function of the containment, countermeasures mitigating release of radioactive material into the environment (accident management measures, back-filling and extended design), assessment of timing and amounts of released radioactive material (source term).

Content Physical basic understanding of severe accident phenomenology: loss of core cooling, core dryout, fuel heat-up, fuel rod cladding oxidation and hydrogen production, loss of core coolability and, fuel melting, melt relocation and melt accumulation in the lower plenum of the reactor pressure vessel (RPV), accident evolution at high and low reactor coolant system pressure, heat flux from the molten debris in the lower plenum and its distribution to the lower head, RPV failure and melt ejection, direct containment heating, molten corium and concrete interaction, in- and ex-vessel molten fuel coolant interaction (steam explosions), hydrogen distribution in the containment, hydrogen risk (deflagration, transition to detonation), pressure build-up and containment vulnerability, countermeasures mitigating/avoiding hydrogen deflagration, formation, transport and deposition of radioactive aerosols, iodine behavior, plant ventilation-filtration systems, filtered venting to avoid containment failure and mitigate activity release into the environment, containment bypass scenarios, source term assessment, in-vessel and ex-vessel corium retention, behavior of fuel elements in the spent fuel pool during long-lasting station blackout, cladding oxidation in air, discussion of occurred severe accidents (Harrisburg, Chernobyl, Fukushima), internal and external emergency response. Probabilistic assessment and interfacing with severe accident phenomenology.

Lecture notes Hand-outs will be distributed
Prerequisites / notice Prerequisites: Recommended courses: 151-0156-00L Safety of Nuclear Power Plants plus either 151-0163-00L Nuclear Energy Conversion or 151-2015-00L Reactor Technology

151-2045-00L Decommissioning of Nuclear Power Plants W+ 4 credits 3G A. Pautz, H.M. Prasser


Objective Students get an overview on the challenges of decommissioning and dismantling of nuclear installations. They are well introduced in the current state-of-the-art dismantling technologies as well as in the regulatory requirements. They know how to protect and minimize the impact to workers, the public and the environment. They recognize the importance of optimization of radioactive waste, of achieving a proper end state and a sustainable re-use.

Content The use of imaging and remote sampling systems is discussed, as well as novel detection and sample analysis technologies. Experience with robotics, remote systems and innovative cutting technologies are presented. A wide array of subjects including understanding of chemical and physical processes being used for decontamination. Addressing of challenges and technologies and fundamental research to better understand interactions between waste, packaging and disposal environs. Site characterization towards end state, post-decommissioning challenges and technologies. Exploring the obstacles that must be overcome bring innovative solutions and technologies to bear on nuclear decommissioning. Reference is made to the challenges of getting new technologies into the field of decommissioning projects. A survey of decommissioning costing and human resources needs of skills and mind-setting is given.

Lecture notes The script will be handed out.

Electives Course from the catalogue of Master courses ETH Zurich and EPFL. At least 4 credit points must be collected from the offer of GESS compulsory electives at ETH Zurich or Management of Technology and Entrepreneurship at EPFL.

Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-1021-00L</td>
<td>Industrial Internship Nuclear Engineering Only for Nuclear Engineering MSc.</td>
<td>O</td>
<td>8</td>
<td>external organisers</td>
<td></td>
</tr>
</tbody>
</table>

Abstract The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy.

Prerequisites / notice The internship must be approved by the tutor.

Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1020-00L</td>
<td>Semester Project Nuclear Engineering Only for Nuclear Engineering MSc.</td>
<td>O</td>
<td>8</td>
<td>17A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract The subject of the Semester Project and the choice of the supervisor (ETH or EPFL professor) are to be approved in advance by the tutor.

Objective The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1009-00L</td>
<td>Master's Thesis Nuclear Engineering Only students who fulfil the following criteria are allowed to begin with their Master Thesis: a. Successful completion of the Bachelor programme b. Any additional requirements for admission to the degree programme have been fulfilled</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>
c. Have achieved a total of at least 72 credits in the categories "Core Subjects" and "Electives"

d. Successful completion of the Semester Project (the corresponding credits have been acquired)

The supervisor of the Master Thesis and the choice of the supervisor (ETH or EPFL professor) are to be approved in advance by the tutor.

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

### Nuclear Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>Credit Eligibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td>W+</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
<td>W</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>Credit Eligibility</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>Lecture</td>
<td>P</td>
</tr>
<tr>
<td>G</td>
<td>Lecture with exercise</td>
<td>A</td>
</tr>
<tr>
<td>U</td>
<td>Exercise</td>
<td>D</td>
</tr>
<tr>
<td>S</td>
<td>Seminar</td>
<td>R</td>
</tr>
<tr>
<td>K</td>
<td>Colloquium</td>
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</tbody>
</table>

### ECTS

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Pharmaceutical Sciences Bachelor

First Year

First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

Abstract
First identification with Pharmaceutical Sciences; motivation for profiling in the Natural Sciences, which are focused on within the first two years as a preparation for the specialized studies; sensitization for the duties and the responsibilities of a person with a federal diploma in Pharmacy; information about job opportunities.

Objective
First identification with Pharmaceutical Sciences; motivation for profiling in the Natural Sciences as a preparation for the specialized studies; sensitization for the duties and the responsibilities of a person with a federal diploma in Pharmacy; information about job opportunities.

Content
Introduction to Pharmaceutical Sciences by selected milestones of research and development. Overview on research activities at the Institute of Pharmaceutical Sciences that is focussed on drug delivery and development (from concepts to prototypes). Sensitization for communication skills and information management. Demonstration of job opportunities in community pharmacies, in the hospital, in industry, and in the public sector by experts in the different fields.

Lecture notes
Handouts for individual lectures.

Prerequisites / notice
Interactive teaching

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<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0291-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6 credits</td>
<td>4V+2U</td>
<td>A. Caspar</td>
</tr>
</tbody>
</table>

Abstract
Mathematics I/II is an introduction to one- and multidimensional calculus and linear algebra emphasizing on applications.

Objective
Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences. Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.

Content

## Eindimensionale diskrete Entwicklungen ##
- linear, exponentiell, begrenzt, logistisch
- Fixpunkte, diskrete Veränderungsrate
- Folgen und Grenzwerte

## Funktionen in einer Variablen ##
- Reproduktion, Fixpunkte,
- Periodizität,
- Stetigkeit

## Differentialrechnung (I) ##
- Veränderungsrate/-geschwindigkeit
- Differentialquotient und Ableitungsfunktion
- Anwendungen der Ableitungsfunktion

## Integralrechnung (I) ##
- Stammfunktion
- Integrationstechniken

## Gewöhnliche Differentialgleichungen (I) ##
- Qualitative Beschreibung an Beispielen:
- Beschränkt, Logistisch, Gompertz
- Stationäre Lösungen
- Lineare DGL 1. Ordnung
- Trennung der Variablen

## Lineare Algebra ##
- Erste Arithmetische Aspekte
- Matrizenrechnung
- Eigenwerte / -vektoren
- Quadratische LGS und Determinante

Lecture notes
In Ergänzung zu den Vorlesungskapiteln der Lehrveranstaltungen fassen wir wichtige Sachverhalte, Formeln und weitere Ausführungen jeweils in einem Vademecum zusammen. Die pdfs finden Sie unter Lernmaterial > Dokumente.

Dabei gilt:

* Die Skripte ersetzen nicht die Vorlesung und/oder die Übungen!
* Ohne den Besuch der Lehrveranstaltungen verlieren die Ausführungen ihren Mehrwert.
* Details entwickeln wir in den Vorlesungen und den Übungen, um die hier bestehenden Lücken zu schliessen.
* Prüfungsrelevant ist, was wir in der Vorlesung und in den Übungen behandeln.
**Literatur**

**Th. Wihler**
Mathematik für Naturwissenschaften, 2 Bände: Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB.

**H. H. Storrer**
Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser.
Via ETHZ-Bibliothek:
http://link.springer.com/book/10.1007/978-3-0348-8598-0/page/1

**Ch. Blatter**
Lineare Algebra; VDF auch als [pdf](http://www.math.ethz.ch/~blatter/dlp.html)

---

**Prerequisites / notice**

## Übungen und Prüfungen ##

+ Die Übungsaufgaben (inkl. Multiple-Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung.
+ Es wird erwartet, dass Sie mindestens 75 % der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.
+ Der Prüfungsstoff ist eine Auswahl von Themen aus Vorlesung und Übungen. Für eine erfolgreiche Prüfung ist die konzentrierte Bearbeitung der Aufgaben unerlässlich.

## Einschreibung in die Übungen ##

Die Einschreibung in die Übungsgruppen erfolgt online. Alle unter http://www.mystudies.ethz.ch/ für die Vorlesung Eingeschriebenen erhalten rechtzeitig per Email einen personalisierten Link zur Einschreibung. Behalten Sie diesen Link.

## Zugang Übungsserien ##

Erfolgt auch online. Alle unter http://www.mystudies.ethz.ch/ für die Vorlesung Eingeschriebenen erhalten rechtzeitig per Email einen 2. personalisierten Link. Behalten Sie auch diesen Link.

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**252-0852-00L Foundations of Computer Science**

4 credits

J. Hromkovic, H.J. Böckenhauer, M. Dahinden, L. E. Fässler, D. Komm

Abstract

Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

Objective

The students learn to

- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Content

1. The role of computer science in science
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

Lecture notes

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

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**529-1011-00L Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci. & Tech.)**

4 credits

C. Thilgen

Abstract

Fundamentals of Organic Chemistry: molecular structure. Bonding and functional groups; nomenclature; resonance and aromaticity; stereochemistry; conformation; bond strength; organic acids and bases; basic reaction thermodynamics and kinetics; reactive intermediates: carbanions, carbenium ions and radicals.

Objective

Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Understanding the relationship between structure and reactivity.

---

**529-1001-01L General Chemistry (for Biology/Pharmacy/HST)**

4 credits

W. Uhlig

Abstract

The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

Objective

The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.

Content


Weiterführende Literatur:
Brown, LeMay, Bursten CHEMIE (deutsch)
Housecroft and Constable, CHEMISTRY (englisch)
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

---

Content

Lecture notes
Printed lecture notes are available. Exercises, answer keys and other handouts can be downloaded from the Moodle course "Organic Chemistry I" of the current semester (https://moodle-app2.let.ethz.ch).

Literature
Supplementary textbooks:

Prerequisites / notice
The course consists of plenary lectures (2 h per week) and problem-solving lessons (2 h per week, groups of ca. 25 people). In addition, online exercises are available in the e-learning environment Moodle (Course "OC I").

535-0651-00L Fundamentals of Biology IA O 5 credits 5G M. Aebi, E. Hafen

Objective
The course provides an introduction to the basics of molecular- and cell biology and genetics.

Content
Introduction to modern biology and to principal biological concepts.

535-0671-00L Communication and Social Competences O 1 credit 1V J. Stadelwieser

Objective
Students . . .

Content
(1) recognize the importance of effective communication/presentation regarding objectives and audience;
(2) know the basics of rhetoric, communication, presentation, learning and working techniques;
(3) are enabled to prepare presentations (with slides/powerpoint);
(4) know four types of protocols;
(5) are enabled to write protocols;
(6) know possibilities to optimize their learning and working success;
(7) are enabled to scrutinize a scientific text.

Laboratory Course General Chemistry (for Biology and Pharmacy) O 6 credits 8P R. O. Kissner, K.H. Altmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle

Abstract
Introduction to the practical work in a chemistry laboratory. The most important manipulations and techniques are treated, as well as the most fundamental chemical reaction types.

Objective
- Knowledge of the basic chemical laboratory methods.
- Basic knowledge of the scientific approach in experimenting.
- Observation and interpretation of real-world chemical processes.
- Keeping of a reliable laboratory journal.

Content
- Simple chemical methods and calculations.
- Separation techniques.
- Simple physical measurements.
- Ionic solids (salts).
- Acid/Base chemistry, buffers.
- Redox reactions.
- Metal complexes.
- Titration methods.
- Introduction to qualitative analysis.
Lecture notes: Course manual (is handed out to the students at the beginning of the lessons).
Language: German, English upon request.

is a suitable textbook.

Prerequisites / notice: This practical course causes costs for materials and chemicals. The costs are charged to the students at the end of the semester.

► Second Year

★★ Second Year Core Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1042-00L</td>
<td>Principles of human embryology, anatomy and histology</td>
<td>O</td>
<td>2</td>
<td>1.5G</td>
<td>M. Badertscher</td>
</tr>
<tr>
<td>Objective</td>
<td>Knowledge of the necessary basics and the possibilities of application of the relevant spectroscopical and separation methods in analytical chemistry.</td>
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</tr>
</tbody>
</table>

Lecture notes: A comprehensive script is available in the HCI-Shop. A summary of the part *Spektroskopie* defines the relevant material for the exam.

- Prettsch E., Bühlimann P., Badertscher M., Spektroskopische Daten zur Strukturaufklärung organischer Verbindungen, fünfte Auflage, Springer-Verlag, Berlin 2010;
- K. Cammann, Instrumentelle Analytische Chemie, Verfahren, Anwendungen, Qualitätssicherung, Spektrum Akademischer Verlag, Heidelberg, 2001;

Prerequisites / notice: Prerequisites:
- 529-1001-01 V “Allgemeine Chemie I (für Biol./Pharm.Wiss.)”
- 535-1001-00 P “Allgemeine Chemie I (für Biol./Pharm.Wiss.)”
- 529-1011-00 G “Organische Chemie I (für Biol./Pharm.Wiss.)”

535-0223-00L Pharmaceutical Analytics I O 1 credit 1.5G I. A. Werner Kaeslin
Abstract: Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.
Objective: Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmacopeial texts and monographs.
Content: Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacopeias.
Lecture notes: The script can be downloaded from the IPW homepage, “course materials”.

Prerequisites / notice: A passed exam of the annual course (Pharmaceutical Analytics I and II) is required for admission to the laboratory course in Pharmaceutical Analytics 535-0219-00.

376-0151-01L Anatomy I O 3 credits 2V M. Ristow, L. Slomianka, D. P. Wolfer
Abstract: Principles of human embryology, anatomy and histology
Objective: Basic knowledge of human embryology, anatomy and histology with focus on vegetative Anatomy; understanding structure - function relationships.
Content: 3rd semester: histology, embryology, nervous system and sensory organs, cardiovascular system, respiratory system
Literature: Buchempfehlungen: http://www.dpwolfer.ch/dpwolfer/TEAstu-ge.htm

376-0151-02L Physiology I O 3 credits 2V M. Ristow, M. Flück, C. Spengler, N. Wenderoth
Abstract: Basic knowledge of the anatomy and physiology of tissues, the embryonal and postnatal development, the cardiovascular system, kidney, the intestines and the basics of pathology.
Objective: Foundations of human anatomy and physiology and basics of clinical pathophysiology.
Content: 3rd semester: Cytology, histology, embryology, blood, heart, blood vessels, urinary system, water, electrolyte, and acid-base balance, digestive system, general pathology.
4th semester: Respiratory system, skin, endocrine system, neuroanatomy, sense organs, muscular and nervous tissue, motor system, thermoregulation, male and female reproductive system, pregnancy and child birth.
Lecture notes: Müttener und Wolfer: “Anatomie und Physiologie”;
www.pharma.ethz.ch/en/teaching/dipl.stud/course.materialsdipl.stud.html
Physiologie: Schmidt/Lang/Thews: Physiologie des Menschen, Springer-Verlag,Heidelberg

551-0103-00L Fundamentals of Biology II: Cell Biology O 5 credits 5V E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner
Abstract: The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.
Objective
The goal of this course is to provide students with a wide general understanding of cell biology. With this material as a foundation, students will have a solid cell biological basis to begin their specialization not only in cell biology, but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Lecture notes
The lectures are presented in the Powerpoint format. These are available online on the ETH Zürich Virtual Learning Environment (Livestream) at the above mentioned website.

Literature

Prerequisites / notice
Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

551-1323-00L Fundamentals of Biology II: Biochemistry and Molecular Biology

Abstract
The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biological aspects. Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, lipids, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

Lecture notes

Prerequisites / notice
Some of the lectures are given in the English language.

529-1023-00L Physical Chemistry I (for Biology and Pharmacy)

Abstract

Objective
Understanding the fundamental thermodynamical properties of chemical and biological systems.

Content

Lecture notes
In process, will be distributed at the beginning of the first lecture

Literature

Prerequisites / notice
Prerequisite: mathematics I-II, functions of multiple variables, partial derivatives.

Lab Courses 2nd Year

Number Title
529-0229-00L Practical Course Organic Chemistry (for Students of Biology and Pharmaceutical Sciences)

Abstract
Latest online enrolment is one week before the beginning of the semester.

Objective
Learn the basic techniques for the preparation and purification of organic compounds. Learn to take accurate notes of the experiments. Deepen the understanding of reaction mechanisms.

Content
Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography)
Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

Lecture notes
Documentation will be handed out at the beginning of the course.

Literature
1) P. Wörl, M. Bitzer, U. Claus, H. Felber, M. Hübel, B. Vollweider, Laborpraxis (Bd. 1: Einführung, allgemeine Methoden; Bd. 2: Messmethoden; Bd. 3: Trennungsmethoden; Bd. 4: Analytische Methoden), Birkhäuser Verlag.

Prerequisites / notice
Prerequisite: mathematics I-II, functions of multiple variables, partial derivatives.

Third Year

Third Year Core Subjects

Number Title
535-0230-00L Medicinal Chemistry I

Abstract
The lectures give an overview of selected drugs and the molecular mechanisms underlying their therapeutic effects in disease. The historical and modern-day methods by which these drugs were discovered and developed are described. Structure-function relationships and the biophysical rules underlying ligand-target interactions will be discussed and illustrated with examples.

Objective
Basic understanding of therapeutic agents with respect to molecular, pharmacological and pharmaceutical properties.

Content
Molecular mechanisms of action of drugs. Structure function and biophysical basis of ligand-target interactions

Lecture notes
Will be provided in parts before each individual lecture.

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 1108 of 1432
The two-semester lecture course will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action between pharmacological, pathophysiological and clinical aspects. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicology, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered.

**Literature**

- J.C. L. Leroux, O. Glander, C.-D. Herzfeldt und J. Kreuter (Hrsg.) Grundlagen der Arzneiformenlehre, Springer Verlag, Berlin 1999
- H. Leuenberger (Hrsg.) - Physikalische Pharmazie, Wissenschaftliche Verlagsgesellschaft, Stuttgart 2002
- R. Voigt, Pharmazeutische Technologie, 10. Auflage, Deutscher Apotheker Verlag, Stuttgart, 2006

The lectures provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.

**Prerequisites / notice**

- Attendance of Medicinal Chemistry II in the spring semester.
- Requirements: Knowledge of physical and organic chemistry, biochemistry and biology.

**Language:** German and English
Pharmaceutical Biology

K.H. Altmann

The lecture is centered around the discussion of medicinal plants and herbal medicines and their common medical applications. The main areas addressed in the lecture are (a) the structure and biosynthesis of plant constituents (i.e. plant-derived natural products) and (b) the pharmacological effects and therapeutic applications of biogenic drugs of plant origin (herbal medicines based on plant extracts as well as isolated natural products). The basic pathways for the biosynthesis of the most important classes of plant-derived natural products are discussed in detail. Likewise, the molecular basis of the pharmacological effects of medicinal plant extracts (and derived herbal medicines) and their individual constituent components (isolated natural products) is broadly addressed. As part of this discussion the availability of clinical data (or lack thereof) to support specific clinical applications of herbal medicines will be repeatedly highlighted. Potential risks associated with the use of herbal medicines are discussed for selected cases.

The lecture is structured according to the major classes of natural products prevalent in medicinal plants and herbal medicines: Carbohydrates, lipids, terpenes, phenolic compounds, alkaloids, essential oils.

Radiopharmaceutical Chemistry

The structure and biosynthesis of plant constituents and the pharmacological effects and therapeutic applications of biogenic drugs of plant origin (extract-based herbal medicines; isolated natural products) are discussed. Areas of focus are (a) major biosynthetic pathways for plant-derived natural products, (b) pharmacological effects of herbal extracts, and (c) molecular mechanisms of action.

The lecture is centered around the discussion of medicinal plants and herbal medicines and their common medical applications. The main areas addressed in the lecture are (a) the structure and biosynthesis of plant constituents (i.e. plant-derived natural products) and (b) the pharmacological effects and therapeutic applications of biogenic drugs of plant origin (herbal medicines based on plant extracts as well as isolated natural products). The basic pathways for the biosynthesis of the most important classes of plant-derived natural products are discussed in detail. Likewise, the molecular basis of the pharmacological effects of medicinal plant extracts (and derived herbal medicines) and their individual constituent components (isolated natural products) is broadly addressed. As part of this discussion the availability of clinical data (or lack thereof) to support specific clinical applications of herbal medicines will be repeatedly highlighted. Potential risks associated with the use of herbal medicines are discussed for selected cases.

The lecture is structured according to the major classes of natural products prevalent in medicinal plants and herbal medicines: Carbohydrates, lipids, terpenes, phenolic compounds, alkaloids, essential oils.

Gene Technology

The aim of the lecture course is to provide a solid overview of the science and issues in gene technology and genome science.

Introduction of basic principles of radiation, structure and function of radiopharmaceuticals, examples of radiopharmaceuticals in nuclear medicine practice, pharmacokinetics and half-life extension.

Proteins: chemical modification and detection of biomolecular interactions

Principles of phage display
Phage display selection methodologies
Other phage libraries (peptides, globular proteins, enzymes)
DNA-encoded chemical libraries

Genome projects, genome sequencing
Transcriptomics
Proteomics
Principles of Cancer
Principles of Vaccine Development
Principles of Gene Therapy

Consideration on pharmacokinetics and half-life extension

Pharmacological Immunology

D. Neri, C. Halin Winter

Topics: Antibody phage technology, protein modification technology, genome projects, genome sequencing, transcriptomics, proteomics and SNP technology. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.

Abstract

Get Students familiar with basic Immunological concepts of pharmaceutical relevance.

Introduction of basic principles of radiation, structure and function of radiopharmaceuticals, examples of radiopharmaceuticals in nuclear medicine practice, discussion of functional radiopharmaceuticals, nuclear medicine practice, discussion of functional radiopharmaceuticals, molecular imaging, targeted radionuclide therapy, radiopharmaceutical synthesis.

Principles of phage display
Phage display selection methodologies
Other phage libraries (peptides, globular proteins, enzymes)
DNA-encoded chemical libraries

Introduction to the major classes of natural products prevalent in medicinal plants and herbal medicines: Carbohydrates, lipids, terpenes, phenolic compounds, alkaloids, essential oils.

The basic pathways for the biosynthesis of the most important classes of plant-derived natural products are discussed in detail. Likewise, the molecular basis of the pharmacological effects of medicinal plant extracts (and derived herbal medicines) and their individual constituent components (isolated natural products) is broadly addressed. As part of this discussion the availability of clinical data (or lack thereof) to support specific clinical applications of herbal medicines will be repeatedly highlighted. Potential risks associated with the use of herbal medicines are discussed for selected cases.

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Principles of Vaccine Development
Principles of Gene Therapy

Consideration on pharmacokinetics and half-life extension

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Phage display selection methodologies
Other phage libraries (peptides, globular proteins, enzymes)
DNA-encoded chemical libraries

Introduction to the major classes of natural products prevalent in medicinal plants and herbal medicines: Carbohydrates, lipids, terpenes, phenolic compounds, alkaloids, essential oils.

The basic pathways for the biosynthesis of the most important classes of plant-derived natural products are discussed in detail. Likewise, the molecular basis of the pharmacological effects of medicinal plant extracts (and derived herbal medicines) and their individual constituent components (isolated natural products) is broadly addressed. As part of this discussion the availability of clinical data (or lack thereof) to support specific clinical applications of herbal medicines will be repeatedly highlighted. Potential risks associated with the use of herbal medicines are discussed for selected cases.

The lecture is structured according to the major classes of natural products prevalent in medicinal plants and herbal medicines: Carbohydrates, lipids, terpenes, phenolic compounds, alkaloids, essential oils.
Characterisation of the biophysical and biological properties of drugs.

Lecturers

ECTS

Type

Knowledge of experimental methods in drug discovery and development

O

Lecturers

V

Solving analytical problems. Development and interpretation of analytical methods.

Original literature


- K. Fent, J. Hall

Thorough knowledge of major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

Prerequisites / notice

Basic knowledge of biochemistry, general microbiology, immunology

Laboratory Courses 3rd Year

Respective lectures must be attended before/together with the Laboratory Courses. Special schedule for the Laboratory Courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>535-0219-00L</td>
<td>Laboratory Course in Pharmaceutical Analytics</td>
<td>O</td>
<td>3 credits</td>
<td>7P</td>
<td>I. A. Werner Kaeslin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Solving analytical problems; Development and interpretation of analytical methods.</td>
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<tr>
<td>Objective</td>
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<tr>
<td>Content</td>
<td>Solving analytical problems; Development and interpretation of analytical methods.</td>
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<tr>
<td>Literature</td>
<td>Skript Pharmazeutische Chemie Praktikum</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Requirements:</td>
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<tr>
<td>Literature</td>
<td>- SR 2004: 2 credits Analytical Chemistry (529-1041-00), lecture Pharmaceutical Analytics</td>
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<tr>
<td>Literature</td>
<td>- SR 2013: 6 credits Analytical Chemistry/Pharmaceutical Analytics or 36 credits of compulsory lectures 2nd year.</td>
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<tr>
<td>Literature</td>
<td>- Epidemiology</td>
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<tr>
<td>Literature</td>
<td>- Therapeutic regimens commonly used against bacterial and fungal pathogens</td>
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<tr>
<td>Literature</td>
<td>- Symptoms and diagnosis of major bacterial and fungal pathogens</td>
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<tr>
<td>Literature</td>
<td>- Detection and identification of bacterial, mycobacterial and mycological pathogens as well as microbial susceptibility testing.</td>
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<tr>
<td>Literature</td>
<td>- Safe lab-technical handling is imperative, because pathogens of risk groups 1 and 2 are cultured. Therefore aseptic techniques need to be learned together with the basics in sterilization, disinfection and preservation.</td>
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<tr>
<td>Literature</td>
<td>- Basics of Bio-Safety.</td>
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<tr>
<td>Literature</td>
<td>- Analysis of simulated clinical specimens using classical methods of Medical Microbiology (microscopy, culture etc.).</td>
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<tr>
<td>Literature</td>
<td>- The students work in groups and gain insight into the procedures in a routine clinical microbiological laboratory.</td>
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<tr>
<td>Literature</td>
<td>- Using a scriptum, they learn how to identify pathogens and test them for antimicrobial susceptibility.</td>
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<tr>
<td>Literature</td>
<td>- As single groups can work only on a fraction of the cases, results and observations are shared by short presentations through all groups.</td>
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<tr>
<td>Literature</td>
<td>- Registration for the course until 15 October;</td>
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<tr>
<td>Literature</td>
<td>- Attendance of the lecture Medical Microbiology in the same semester or earlier;</td>
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<tr>
<td>Literature</td>
<td>- Basic skills in careful laboratory work.</td>
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<tr>
<td>Literature</td>
<td>- A. Lehner</td>
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</tbody>
</table>

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<tbody>
<tr>
<td>535-0166-00L</td>
<td>Medical Microbiology Practical Course</td>
<td>O</td>
<td>1 credit</td>
<td>1G</td>
<td>A. Lehner</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic Training in Practical Medical Microbiology.</td>
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<tr>
<td>Objective</td>
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<tr>
<td>Content</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Literature</td>
<td>The scriptum (in German) will be distributed at the beginning of the course. It contains all protocols necessary for the practical work</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Requirements:</td>
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<tr>
<td>Literature</td>
<td>- Basic skills in careful laboratory work.</td>
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<tr>
<td>Literature</td>
<td>- D. Neri</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0239-00L</td>
<td>Practical Course in Medicinal Chemistry</td>
<td>O</td>
<td>3 credits</td>
<td>7P</td>
<td>J. Hall, M. Detmar, C. Halin Winter, D. Neri</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course comprises experiments relating to concepts of medicinal chemistry including statistical processing, fitting of experimental data, computer modeling of protein structures, experimental measurement of affinity constants and kinetic dissociation constants for protein ligands. The chemical stability of a drug will be studied. Basic gene cloning and protein expression will be introduced.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of experimental methods in drug discovery and development</td>
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<tr>
<td>Content</td>
<td>Characterisation of the biophysical and biological properties of drugs.</td>
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<tr>
<td>Literature</td>
<td>Scripts</td>
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<tr>
<td>Literature</td>
<td>Original literature</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Requirements:</td>
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<tr>
<td>Literature</td>
<td>Laboratory course in Pharmaceutical Analytics;</td>
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<tr>
<td>Literature</td>
<td>Lecture Medicinal Chemistry I in the same semester or earlier.</td>
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</tr>
<tr>
<td>Literature</td>
<td>- J. Hall, M. Detmar, C. Halin Winter, D. Neri</td>
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</table>

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<tr>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0297-00L</td>
<td>Applied Ecotoxicology</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>K. Fent</td>
</tr>
<tr>
<td>Abstract</td>
<td>Besides regarding basic concepts, this lecture focus on applied aspects of ecotoxicology. Case studies and effects of environmental chemicals on cells, organisms up to ecosystems are regarded. In a multidisciplinary approach based on toxicological concepts, pollutants are analysed, in particular hormonally active compounds and their effects on reproduction.</td>
<td></td>
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</tbody>
</table>
Objective

This lecture focusses on basic concepts of ecotoxicology and their application to environmental chemicals and environmental pollution problems. Basic concepts are regarded with respect to their consequences for the environment. Toxicological effects on organisms are analysed at different levels of organisation, from the molecular to the ecosystem level. Case studies are regarded in order to understand chemical’s actions and their effects. In addition bioaccumulation and their consequences, the methods in ecotoxicology and environmental evaluation of various compounds will be regarded. Emphasis will be placed on hormonally active compounds and their effects to aquatic organisms. Furthermore, methods of environmental risk assessment of environmental pollutants will be discussed.

Content


Lecture notes


Literature


375-0021-00L Introduction to Biomedical Engineering I W 4 credits 3G R. Müller, P. Christine, J. G. Snedeker, M. Zenobi-Wong

Abstract

Introduction to biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering.

Objective

Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.

Content

Tissue and Cellular Biomechanics, Molecular Biomechanics and Biopolymers, Computational Biomechanics, Biomaterials, Tissue Engineering, Radiation and Radiographic Imaging, Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging, Biomedical Optics and Lasers.

Lecture notes

Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/ as BIO44

Literature


Academic Press

375-1305-00L Development of the Nervous System W 3 credits 2V E. Stoeckli, further lecturers

Abstract

The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

Objective

The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.

Content

The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Lecture notes

Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/ as BIO44

Literature

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice

Auxiliary tools: None. Bring something to write and your student ID

376-1305-01L Structure, Plasticity and Repair of the Nervous System W 3 credits 2V M. E. Schwab, L. Fili, K. A. Martin, further lecturers

Abstract

The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective

The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content

The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair; networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes

ETH students: Lecture notes will be provided on Moodle https://moodle-app22.let.ethz.ch/course/view.php?id=694

Password will be provided at the beginning of the lecture.

Literature

UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

Prerequisites / notice

Repetitionsprüfung 15. Juni 2016, HG E 26.1, 9-10.30h

376-1714-00L Biocompatible Materials W 4 credits 3G K. Manirula, J. Möller, M. Zenobi-Wong

Abstract

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective

The class consists of three parts: 1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials. 2. The concept of biocompatibility. 3. Introduction into methodology used in biomaterials research and application.

Content

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes

Handouts can be accessed online.

Literature


(available online via ETH library)

Handouts provided during the classes and references therein.

551-0313-00L Microbiology (Part I) W 3 credits 2V W. D. Harte, L. Eberl, H. M. Fischer,
The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease. The lectures Food Chemistry I and Food Chemistry II constitute a unit.

Abstract

To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Objective

To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Content

Descriptive chemistry of food constituents (proteins, lipids, carbohydrates, plant phenolics, flavour compounds).

Reactions which affect the colour, flavour, texture, and the nutritional value of food raw materials and food products during processing, storage and preparation in a positive or in a negative way (e.g. lipid oxidation, Maillard reaction, enzymatic browning).

Links to food analysis, food processing, and nutrition.

Lecture notes

The lectures are supplemented with handouts.

Literature

H.-D. Belitz, W. Grosch, P. Schieberle, Lehrbuch der Lebensmittelchemie, Springer-Verlag, Berlin, Heidelberg. 2008

752-4005-00L  Food Microbiology I  W  3 credits  2V  M. Loesner

Abstract

This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

Objective

The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.
Content

1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP’s of Food Microbiology
2. Overview of Microorganisms in Foods
   2.1. Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes

Electronic copies of the presentation slides (PDF) will be made available for download.

Literature

Recommendations will be given in the first lecture.
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- **Probiotics and Prebiotics**: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- **Bioprotective Cultures and Antimicrobial Metabolites**: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- **Legal and Protection Issues Related Functional Foods**

- **Industrial Biotechnology of Flavor and Taste Development**

- **Safety of Food Starter Cultures and Probiotics**

Students will be required to complete a group project on food products and ingredients with or from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

A list of references will be given at the beginning of the course for the different topics presented during this course.

**Literature**

Copy of the power point slides from lectures will be provided.

**752-6101-00L Nutrition and Chronic Disease (HS)**

- **Abstract**
  - To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

- **Objective**
  - To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

- **Content**
  - The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

- **Lecture notes**
  - There is no script. Powerpoint presentations will be made available on-line to students.

- **Lecture notes**
  - To be provided by the individual lecturers, at their discretion.

- **Prerequisites / notice**
  - No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

**752-6105-00L Epidemiology and Prevention**

- **Abstract**
  - The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

- **Objective**
  - Students are able
    - to evaluate the scientific evidence on the effects of diet on human health
    - to describe the role of nutritional factors in the prevention of chronic diseases
    - to assess the nutritional status of a population (Switzerland taken as an example)
    - to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

- **Content**
  - The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

**752-5001-00L Food Biotechnology I**

- **Abstract**
  - Basic information for understanding biotechnology applied to food processing will be presented. This will include a presentation of the physiology of important productive microorganisms used in food fermentations, closely related to applications in biotechnology; microbial kinetics, and design and operation of bioreactors; and application of modern molecular tools for food biotechnology.

- **Objective**
  - The main goal for this course is to provide students with basic information for understanding biotechnology applied to food processing. For the students, the aim will be:
    - To understand the important role of microbial physiology and molecular tools for food biotechnology;
    - To understand basic principles of fermentation biotechnology, with particular emphasis on food applications.

- **Content**
  - Biotechnology has been defined as any technique that uses living organisms, or substances from those organisms, to make or modify a product, to improve plants or animals, or to develop microorganisms for specific uses. In this course, basic knowledge for understanding biotechnology as applied to food processing will be presented. This course builds on the application of principles learned from other basic courses in the Bachelor program, especially microbiology and microbial metabolism, molecular biology, biochemistry, physics and engineering. Students will learn about the physiology of important productive microorganisms (lactic acid bacteria, bifidobacteria, propionibacteria and fungi) used in food fermentations, closely related to applications in biotechnology. Microbial kinetics, and design and operation of bioreactors used for both research and industrial scale production of traditional foods and modern food ingredients will be presented. This part will be illustrated by examples of food fermentation processes, representative of specific challenges. Finally, the application of modern molecular tools to food biotechnology will be discussed.

- **Literature**
  - A list of references will be given at the beginning of the course for the different topics presented during the course.

- **Pharmaceutical Sciences Bachelor - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
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</table>

**Compulsory Electives in Humanities, Social and Political Sciences**

- **Recommended GESS compulsory elective courses (Type B) for D-CHAB**

- **see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability**

- **see GESS Compulsory Electives: Language Courses**

**ETN/UEH**

<table>
<thead>
<tr>
<th>Key for Hours</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Pharmaceutical Sciences Master

First Year

Compulsory and Compensatory Courses

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>535-0010-00L</td>
<td>Drug Seminars I</td>
<td>O</td>
<td>0</td>
<td>1S</td>
<td>K.H. Altmann</td>
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<tr>
<td></td>
<td>6 credit points are awarded after successful presentation in the Seminar Week. - Strictly for students enrolled in the Master programmes Pharmaceutical Sciences or MIPS</td>
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</table>

Abstract
Drug therapy is nothing less than interference with a highly complex biological system, which is affected by various internal and external factors. A profound understanding of drug effects thus requires a transdisciplinary approach of investigation. The drug seminars provide a platform for the presentation and discussion of these transdisciplinary approaches for the investigation of drug action.

Objective

- basic mechanisms and regulation of the immune response
- the pathogenic mechanisms of the most important immune-mediated disorders
- the most frequently used expression systems for the production of therapeutic proteins
- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

Content
The faculty members of the Institute of Pharmaceutical Sciences offer specific projects from different areas of the pharmaceutical sciences, each of which is elaborated by a small groups of students (4-8). Each group is tutored by a faculty member. The objective of this work is to achieve an in-depth understanding of the problem investigated and to present the results of the work to an audience composed of all students participating in the drug seminar and the faculty of the Institute of Pharmaceutical Sciences. Presentations will take place in the framework of a dedicated mini-symposium, which is part of the external seminar week. The possibility exists to invite external experts from industry or the public health sector to participate in the mini-symposium. Students are strongly encouraged to make use of this option and will again be supported in these efforts by the faculty members.

Lecture notes
Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

Literature
- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

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<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0030-00L</td>
<td>Therapeutic Proteins</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>C. Halin Winter, D. Neri</td>
</tr>
<tr>
<td></td>
<td>In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.</td>
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</table>

Abstract
Students know and understand:
- basic mechanisms and regulation of the immune response
- the pathogenic mechanisms of the most important immune-mediated disorders
- the most frequently used expression systems for the production of therapeutic proteins
- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

Objective

- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

Content

In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.

The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

Lecture notes
- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

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<tr>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>535-0041-00L</td>
<td>Pharmacology and Toxicology III</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>M. Detmar, U. Quitterer</td>
</tr>
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<td></td>
<td>The course is divided into two parts. The first part provides a detailed understanding of drugs and pharmacotherapy of infectious diseases and cancer. The second part gives an overview of the field of pharmacogenomics with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.</td>
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</table>

Abstract
The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between pathological, pathophysiological and clinical aspects of drug therapy in the fields of infectious diseases and cancer. The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

Objective

- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

Content

- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

Lecture notes
A script is provided for each lecture course. The scripts define important and exam-relevant contents of lectures. Scripts do not replace the lecture.

Literature
- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

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<table>
<thead>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>535-0050-00L</td>
<td>Pharmacopoeidemiology and Drug Safety</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>S. Russmann</td>
</tr>
<tr>
<td></td>
<td>Introduction of principles of pharmacoepidemiology and epidemiology in addressing drug related questions in the population and of epidemiologic perspectives for health care management</td>
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Abstract
Drug therapy is nothing less than interference with a highly complex biological system, which is affected by various internal and external factors. A profound understanding of drug effects thus requires a transdisciplinary approach of investigation. The drug seminars provide a platform for the presentation and discussion of these transdisciplinary approaches for the investigation of drug action.

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Lecture notes
- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

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### Objectives:

To familiarize participants with the principles of pharmacoepidemiology and epidemiology in addressing drug related questions with concern to the use, effects and risks of medicinal products in a large population.

To introduce participants to fundamental statistical, economic and epidemiological concepts and methods.

To provide the appropriate tools to critique pharmacoepidemiologic studies in the literature and to critically read and understand papers in the medical literature which relate to drug benefits, risks, and costs.

To address controversial topics in drug use and benefit-risk assessment, and to critically appraise the outcome of drug therapy.

To equip participants with skills to facilitate further studies in these areas.

### Content:

The contribution of epidemiology to the study of drug uses, effects and risks:
- Pharmacoepidemiology study methodologies, concepts and strategies,
- Detection and identification of unintended drug effects (pharmacovigilance),
- Quantifying unintended effects and drug interactions,
- Bias and confounding by indication,
- Drug utilization

Pharmacoeconomics and outcome assessment of drug therapy.

### Literature

- Rothman K, Greenland S; Modern Epidemiology, 2nd ed. Lippincott, Philadelphia, 1998
- Strom B; Pharmacoepidemiology, 3rd ed. Wiley, Chichester, 2000

### Compensatory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0023-00L</td>
<td>Computer-Assisted Drug Design (Practical Course)  ■ W Dr 4 credits 6P</td>
<td>G. Schneider, J. A. Hiss</td>
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</tr>
<tr>
<td>Abstract</td>
<td>The practical course is open for master and graduate students to get an introduction into hands-on computer-assisted drug design. The class includes an introduction to computer-based screening of a virtual compound library, subsequent synthesis of candidate ligands, and biochemically testing for activity on pharmacoepidemiologically important drug targets. Participants will computationally create and screen a virtual compound library for potential active small molecules. The process will involve an introduction to screening a virtual compound library, synthesizing candidate inhibitors, and biophysical testing against a pharmacoepidemiologically important drug target.</td>
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<tr>
<td>Objective</td>
<td>Participants become familiar with state-of-the-art methodologies in a real-life computer-aided medicinal chemistry project. Participants work as small teams, perform literature research and discuss recent research findings. A seminar talk is to be given presenting the molecular design strategy chosen and the results obtained during the course.</td>
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<tr>
<td>Content</td>
<td>The course offers the possibility for people with and without computational and or laboratory background to get an introduction into computer-assisted drug design, as well as practical training in a modern chemical laboratory. Using various software suites, the participants will computationally create and screen a virtual compound library for potential active small molecules. The process will involve an introduction to screening a virtual compound library, synthesizing candidate inhibitors, and biophysical testing against a pharmacoepidemiologically important drug target.</td>
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<tr>
<td>Lecture notes</td>
<td>Detailed information will be handed out during the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The class is organized as a two-week block course. The number of participants is limited. Kick-off meeting and confirmation of registration (Vorbesprechung und Platzvergabe); During the last lecture of the class &quot;Computer-Assisted Drug Design&quot; (535-0022-00). Ideally, students interested in the course participated and successfully passed the lecture &quot;Computer-Assisted Drug Design&quot; (535-0022-00).</td>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0024-00L</td>
<td>Methods in Drug Design □ Complementary to the practical course &quot;Computer-Assisted Drug Design (Practical Course)&quot; 535-0023-00L. Compulsory for the students of the practical course, open for other interested students.</td>
<td>G. Schneider</td>
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<tr>
<td>Abstract</td>
<td>The lecture is organized as a two-week block during the practical course &quot;Computer-Assisted Drug Design&quot; (535-0023-00 P), totalling 10 two-hour lectures. It provides an introduction to advanced drug design techniques and approaches emphasizing computer-assisted molecular design.</td>
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<tr>
<td>Objective</td>
<td>Participants will learn about computational algorithms and advanced experimental approaches to drug discovery and design, including selected actual topics and practical applications. The contents of the lecture will allow for a deeper understanding of modern computer-assisted drug design methods and how they are linked to experimental applications. The main focus is on computational medicinal chemistry, so that participants will be able to use relevant computer-based methods in own research projects.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Additional selected literature will be provided during the lecture. The lecture is mandatory for all participants of the course &quot;Computer-Assisted Drug Design&quot; (535-0023-00 P).</td>
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### Electives

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0250-00L</td>
<td>Biotransformation of Drugs and Xenobiotics W Dr 1 credit 1V</td>
<td>S.D. Krämer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.</td>
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<tr>
<td>Objective</td>
<td>Goals: knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.</td>
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</tbody>
</table>
In the last 10 years, an average of one drug per year was withdrawn from the market. Using selected examples of such drug failures, the course aims at analyzing the present explanations of drug actions as well as the design and predictive power of animal models and clinical trials. In addition, the ethical, societal, and economical expectations in new drugs shall be reflected. The course focuses on the ethical, societal, economical, and political expectations in the development of new drugs. Examples of herbal drugs and poisons, mode of action, and their ethnopharmacological importance. Critical analysis of bioprospecting as a tool for drug discovery from natural sources. Discussion of the issues around law and international treaties. Importance of ethnopharmaceutical knowledge for world health.

Prerequisites:
Basic lectures in biology or biochemistry and pharmaceutical biology have been attended; not suitable for first semester students.

Content and Literature
Further references will be provided in the course.

Handouts will be provided.

http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).


Further references will be provided in the course.
V. I. Otto

Printouts of the slides used for the lectures and literature for reading and discussions will be available online.

The lecture series provides an introduction to computer applications in medicinal chemistry. A focus is on molecular representations, property predictions, molecular similarity concepts, virtual screening techniques, and de novo drug design. All theoretical concepts and algorithms presented are illustrated by practical applications and case studies.

The students will learn how computer simulation generates ideas for drug design and development, understand the theoretical principles of property prediction and computer-generated compound generation, and understand possibilities and limitations of computer-assisted drug design in pharmaceutical chemistry. As a result, they are prepared for professional assessment of computer-assisted drug design studies in medicinal chemistry projects.

Recommended reading: John Abramson, Overdo$ed America, Harper Perennial, New York 2008

Glycobiology in Drug Development

Abstract

Gaining insight into the glycobiology of therapeutically used glycoproteins. This implies knowing and understanding the glycobic basis of the drug. The current methods to evaluate drug efficacy must consider the influence of glycosylation on the pharmacological behavior. It is crucial to understand the effects of glycosylation on the biopharmaceutical's activity.

Content

1. Proteins bearing a "sugar dress" - Glycans in cell-cell communication and molecular recognition in multicellular organisms
2. Tissue plasminogen activator (t-PA), glucocerebrosidase and the biosynthesis of N-glycans
3. PSSG-1 and the biosynthesis of O-glycans; P-selectin and other lectins
4. The glycoprotein hormones and the production and analysis of therapeutic glycoproteins
5. Monoclonal antibodies and the modification of their therapeutic profile through glycoengineering
6. EPO "the same but different"
7. Current topics: Biosimilars and the currently marketed 'Biopharmaceuticals'

The slides used for the lectures will be provided online.

Requirements: Basic knowledge in molecular biology, protein chemistry and analytics. Basic knowledge in pharmacology.

535-0022-00L

Vitamins in Health and Disease

Abstract

In December 2006, Pfizer stopped a large phase III study on the use of Torcetrapib for the prevention of atherosclerosis and cardiovascular disease. 800 million $ in development costs and 21 billion $ in stocks were annihilated overnight. The failure of Torcetrapib has pinpointed the limitations of an extremely reductionist view of atherosclerosis and it's prevention by drug therapy. It has also highlighted what high expectations we have in a safe and wide applicability of drugs and of their economical success.

Torcetrapib is not a single case. In the last 10 years, on average one drug per year was withdrawn from the market due to lack of efficacy, unexpected side effects or toxicity. This clearly shows that the common investigations and the modern understanding of drug actions are often not sufficient to predict the effects a drug will have in large patient populations.

These are the topics of the present course. Using three particularly informative examples of drug failures, the problems encountered and the concepts and informative value of preclinical and clinical studies will be analyzed and discussed. Furthermore, the ethical, societal, economical and political expectations in new drugs shall be reflected.

Requirements: basic knowledge in Medicinal Chemistry and Pharmacology. Ability to read and understand scientific publications in English.
Vitamins are essential organic compounds that cannot be synthesized by an organism and hence, they have to be acquired from the diet. This lecture will give an overview about the application of vitamins in health and disease.

The aim of this lecture is a critical examination of the students with the topic of "Vitamins in Health and Disease". The students will get an overview of vitamins, of their medical applications and the role of the pharmacist with "over-the-counter" products.

Deficiencies of particular vitamins result in specific diseases such as for example scurvy (vitamin C deficiency). Such disease patterns are usually easily recognized and facile to be treated. The clinical utility of supplementation concerns people with severe deficiencies and a risk of complications. Latent vitamin deficiencies might result in variable disorders and risks. As an example neurological disorders in elderly as a consequence of chronic lack of vitamin B12 should be mentioned. Subclinical deficiencies are often difficult to assess. However, these are exactly the cases where advice of a pharmacist is requested.

A large intake of vitamins by over-supplementation or food fortification might be dangerous (hypervitaminosis). This is in particular the case for fat-soluble vitamins or in the case of constant intake of high amounts of water-soluble vitamins over a long time period.

The lecture 'Vitamins in Heath and Disease' will give an overview over the history and applications of vitamins and their functions to preserve good health. The utility of vitamin supplementation during conditions of deficiencies, potential consequences of a latent deficiency as well as risks of over-supplementation will be discussed.

Hand-outs will be distributed during the lecture (in English).

- Handbuch Nährstoffe, Burgerstein, Trias Verlag ISBN 978-3-8304-6071-8

Requirements: Basic knowledge in biochemistry and pharmacology. Ability to read and understand scientific publications in English.
Abstract
This course will provide an up-to-date, comprehensive review of the industrial perspective at the interface of biomaterials and drugs. This covers regulatory, clinical, pre-clinical and manufacturing concepts. The presentations are provided in an effort to maximize the interaction of student and lecturer.

Objective
- The student will be able to categorize a drug-biomaterial as a "drug" or a "material" from a regulatory perspective and can summarize general regulatory pathways for material/drug development. The student will be able to summarize the current concepts and challenges for the industry at the material-drug interface.
- The student will actively develop innovative, industrial concepts at the drug-biomaterial interface.

Content
This course will provide an up-to-date comprehensive review of the industrial perspective at the interface of biomaterials and drugs. General concepts related to regulatory affairs or such as cost-conscious planning of manufacturing processes will be covered by interactive case studies and in close interaction between students and lecturers. The course covers the future at the biomaterial - implant interface - as it is seen by the industry today - and will be reviewed by experienced and long-standing faculty from industry with the aim to provide a balanced, insightful perspective. From that, clinical development concepts, regulatory pathways and real-life case studies will be discussed with the students. Finally the students - working in small groups of 4-5 - will outline a development pathway for an industrial project and present it to the course and in presence of all faculty to receive maximum feedback to their approaches. The student will become familiar with the major elements required for a successful development and which challenges have to be taken into account to translate an idea into a successful product.

Research Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>535-0565-00L</td>
<td>Research Project</td>
<td>O</td>
<td>10</td>
<td>20A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
The Research Project accustoms students to scientific work.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

Content
Students work on a current field of research.

Master Thesis

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>535-0560-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>40D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a subject area of Pharmaceutical Sciences as chosen by the student.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-CHAB.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Second Year

Compulsory and Compensatory Block Courses

Compulsory Block Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-5501-00L</td>
<td>Applied Pharmacology</td>
<td>O</td>
<td>6</td>
<td>7G</td>
<td>P. Wiedemeier, S. Erni, H. Hartenberg, K. Füchsenschilling</td>
</tr>
</tbody>
</table>

Abstract
Overview of the most important clinical pictures: symptoms, recognition, differentiation, pharmacotherapy for the most important general and special medical indications. Groups of pharmaceutical compounds, active pharmaceutical ingredients, proprietary medicinal products: mechanisms of action, contraindication, therapeutic patterns, side effects, or special medical indications. Students have a thorough knowledge of all clinical pictures and their symptoms regarding outpatient treatment. They know the main groups of indications including active pharmaceutical self-medication and ingredients, mechanisms of action, pharmacokinetics, pharmacodynamics and dosage. They are also able to identify the relevant side effects and interactions.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

Content
Pathophysiology of selected clinical pictures and their main symptoms and clinical parameters. Recognition of alarm symptoms and distinction between pharmaceutical self-medication and the need for medical treatment. Detailed coverage of the pharmacotherapy of all fields of indication encountered in outpatient treatment. Outlining of therapeutic strategies and patterns with regard to suitable pharmaceutical compounds, active pharmaceutical ingredients and representative range of proprietary medicinal products. Discussion of the most important mechanisms of action, contraindications, side effects, and interactions.

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<tbody>
<tr>
<td>535-5502-00L</td>
<td>Pharmaceutical Manufacturing in Small Quantities</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>J. Fröhlich, H. Hartenberg, C. Meier</td>
</tr>
</tbody>
</table>

Abstract
Hands-on course in pharmaceutical manufacturing in the pharmacy according to "GMP regulations for small quantities" defined in the pharmacopoeia: Design and practical approach in compounding of formulas using the most important dosage forms including their risks and quality assurance.

Objective
Students are able to manufacture, to package, to quality-control and document pharmaceutical compounding on their own, "lege artis" and according to GMP regulations, using the appropriate techniques. They know the most important properties of active ingredients and excipients frequently used. They achieve the necessary knowledge including the relevant literature and other sources of information, as well as the legal requirements regarding pharmaceutical manufacturing in small quantities.

Content
To impart knowledge about the principal techniques and processes in the manufacturing of pharmaceuticals in small quantities (formulas), focusing on the design, manufacturing, quality assurance and risk based self-appraisal including the patient specific dispensing. During the practical training periods: by means of pharmaceutical relevant examples the design, the planning, the manufacturing including the correct use of the equipment, the in-process control, the packaging and the quality assurance are practiced for various dosage forms and recipes. Quality assurance and control are mainly risk adapted considering as well hygiene regulations according to current pharmaceutical practice. The participants will thus improve their general GMP knowledge and skills.

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<th>Number</th>
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</thead>
<tbody>
<tr>
<td>535-5503-00L</td>
<td>Institutional Pharmacy</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>P. Wiedemeier, B. Falch, J. Beney</td>
</tr>
</tbody>
</table>
Organisation of institutional environments (emergency hospitals), with special focus on the medication process and institutional pharmaceutical care (continuum of care).

Students understand the concept of continuum of care and its practical implementation. They know the medication process within an institutional environment. They are able to find the necessary information and deal with problems in connection with pharmaceuticals, to evaluate them and to communicate and document their findings adequately. They know how a hospital is organised (procedures, possible problems), responsibilities of the different members of the staff and, most importantly, what the function of a hospital pharmacy is.

Principals of the organisation of institutional environments (emergency hospitals), with special focus on medication processes and institutional pharmaceutical care (circulation of medication, continuum of care), Hygiene regulations, medical products, applications, drug formularies, patient files, SOAP notes, kardex study. Participation at interdisciplinary visits, internal trainings and doctors’ reports as well as visitation of the emergency room. Drug interaction, generic substitution, quality management and pharmaceutical appropriateness.

Basics of Practical Pharmacy

Introduction to managed care systems (Pharmaceutical Care and Public Health): problems with regard to therapy and approaches to solutions, service, first aid and medicinal products. Methods of illness prevention and health promotion. Important additional assortments including complementary medicine. Law and economy in everyday pharmacy, structures of the national health care system.

Students know the most important concepts and methods of pharmaceutical care of patients with regard to OTC and Rx-only drugs as well as the essential concepts and methods of public health, prevention and health care. They master the basic rules concerning the pharmaceutical triage and their implications. For the clinical pictures covered during the course, they are able to make therapeutic plans or accompany and optimize doctor’s orders. Students show an adequate understanding of the rights and duties of pharmacists as medical personnel regarding medical care and service within the framework of the Swiss health care system. They are capable of handling important medical products and instructing patients about their use. Students have the necessary basic skills and applications of first aid and emergency medicine. They know the essence, chances and limits with reference to additional assortments, therapeutic options like phytotherapy, complementary medicine, veterinary pharmacy and non-medical methods of healing. Students have the essential knowledge of legal aspects and regulations concerning pharmacists and know the basics of business administration.

Pharmaceutical Care: possibilities of pharmaceutical care of patients regarding OTC and Rx-only drugs in the officinal pharmacy. Good pharmaceutical triage in practice, introduction to the pharmacueutic validation of prescriptions, recognition of medicinal, patient related, therapeutic problems and the finding of solutions: Choice of therapy (OTC), accompanying and optimizing therapies (Rx), compliance, correct administration of drugs, cooperation with other medical professions in the field of outpatient treatment. Traditional and proactive pharmaceutical service: development of adequate means of documentaries of intervention and consultation as well as pharmaceutical follow-up care. Public health: role and possibilities of officinal pharmacies as partners within the Swiss health care system: primary health care, prevention, campaigns, early detection, instruction and mediation, referral to doctors. Needs of customers, patients and employees, and social interaction. Significance of the medical profession (illness, suffering, promotion of health and well-being). Basic training in first aid, emergency medicine and wound care. Medical products: handling of important applications and instruction of patients. Important and additional forms of therapy and assortments: phytotherapy, complementary medicine, veterinary pharmacy, non-medical methods of healing. Economy and law in everyday pharmacy: overview of the Swiss legal system. Relevant legal framework, jurisdiction and regulations and their meaning with regard to quality assurance for practicing pharmacists. Basics of finance and accounting as well as personnel management and insurance matters.

Organisation and competencies of the various partners within the Swiss health care system, focusing on the intermediate position and the role of pharmacists as part of the medical community.

Compensatory Block Courses

All Elective Block Courses of the second year in Master studies are eligible as Compensatory Block Courses. Elective Block courses take place in Spring Semester.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-0152-AAL</td>
<td>Anatomy and Physiology I+II</td>
<td>E-</td>
<td>10</td>
<td>21R</td>
<td>C. Spengler, D. P. Wolfer</td>
</tr>
<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>E-</td>
<td>4</td>
<td>9R</td>
<td>M. Kalisch</td>
</tr>
</tbody>
</table>

Abstract

Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective

The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content

From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student’s t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation
Overview of the possibilities and limitations in clinical laboratory diagnostics. Indications and methods of everyday parameters are known.

Introduction into medical laboratory diagnostics: immunochemical methods, diagnostics of inflammation, acute myocardial infarction, lipid metabolism, myocardial infarction, diabetes, kidney function, urinary diagnostics, liver function, blood coagulation, blood count, therapeutic drug monitoring and drugs of abuse screening, common diagnostics of liver diseases, point-of-care diagnostics.

Additional admission requirement. Enrolment only for MSc students who need this course as additional admission requirement.

Literature


535-0135-AAL

Clinical Chemistry I

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction into fundamentals of laboratory diagnostics and overview of the laboratory parameters concerning inflammation, lipid metabolism, myocardial infarction, diabetes, kidney function, urinary diagnostics, liver function, blood coagulation, blood count, therapeutic drug monitoring and drugs of abuse screening.

Objective
Overview of the possibilities and limitations in clinical laboratory diagnostics. Indications and methods of everyday parameters are known.

Content
Introduction into medical laboratory diagnostics: immunochemical methods, diagnostics of inflammation, acute myocardial infarction, lipid metabolism, diabetes, kidney function and urinary diagnostics, blood coagulation, blood count, therapeutic drug monitoring, drugs of abuse screening, common diagnostics of liver diseases, point-of-care diagnostics.

Prerequisites / notice
none

535-0222-AAL

Pharmaceutical Analytics

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.

Objective
Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmacopeial texts and monographs.

Content
Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacopeias. Identification, purity testing, stability testing, assays of drugs and drug formulations.

Lecture notes
A script can be purchased at the HCI-Shop, HCI-Building, D floor.

Literature

535-0241-AAL

Biopharmacy

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.

Objective
Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.

Content
Introduction to pharmacokinetics; definition of the most important pharmacokinetic parameters and their calculation from clinical data (compartment model, statistical model); kinetics of absorption (absorption profiles); distribution of drugs and role of protein binding; kinetics of elimination: excretion and biotransformation (physiological model); pharmacokinetic profiling of drugs for therapy optimization and for the analysis of the interaction potential; dosage regimen design.

535-0440-AAL

Quality Management in Pharmaceutical Business

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
- "Statistics for research" by S. Cowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
From within the ETH, this book is freely available online under:
From within the ETH, this book is freely available online under:
http://www.springerlink.com/content/m17578/

E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner
Abstract
The students know the relevance and the role of quality assurance measures to assure quality, efficacy and safety of drugs. The students know the most important Swiss regulations, including the associated European regulations, which are relevant from a quality assurance point of view and they are able to interpret the content of this regulations.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Key</th>
<th>Preceptor</th>
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<tbody>
<tr>
<td>551-0110-AAL</td>
<td>Fundamentals of Biology II: Microbiology</td>
<td>2</td>
<td>E-</td>
<td>J. Vorholt-Zambelli</td>
</tr>
<tr>
<td>Abstract</td>
<td>Structure, function, genetics of prokaryotic microorganisms and fungi.</td>
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<tr>
<td>Lecture notes</td>
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<tr>
<th>Course Code</th>
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<th>Preceptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0108-AAL</td>
<td>Fundamentals of Biology II: Plant Biology</td>
<td>2</td>
<td>E-</td>
<td>W. Gruissem</td>
</tr>
<tr>
<td>Abstract</td>
<td>Water balance, assimilation, transport in plants; developmental biology, stress physiology.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Water balance, assimilation, transport in plants; developmental biology, stress physiology.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>none</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Key</th>
<th>Preceptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>none</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pharmaceutical Sciences Master - Key for Type

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

Key for Hours

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

ECTS  European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Physics (General Courses)

### Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**

Research colloquium

**Prerequisites / notice**

Occasionally, talks may be delivered in German.

---

### Physics (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### First Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-1261-07L</td>
<td>Analysis I</td>
<td>O</td>
<td>10 credits</td>
<td>6V+3U</td>
<td>H. Knörrer</td>
</tr>
<tr>
<td>401-1151-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>E. Kowalski</td>
</tr>
<tr>
<td>402-1701-00L</td>
<td>Physics I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>G. Dissertori</td>
</tr>
<tr>
<td>252-0847-00L</td>
<td>Computer Science</td>
<td>O</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>B. Gärtner</td>
</tr>
</tbody>
</table>

### Minor Courses

### Compulsory Electives in Humanities, Social and Political Sciences

### Second Year Compulsory Courses

#### Examination Block I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2303-00L</td>
<td>Complex Analysis</td>
<td>O</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>R. Pandharipande</td>
</tr>
<tr>
<td>401-2333-00L</td>
<td>Methods of Mathematical Physics I</td>
<td>O</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>G. Felder</td>
</tr>
</tbody>
</table>

---

**Abstract:** Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.

**Objective:** The ability to work with the basics of calculus in a mathematically rigorous way.

**Lecture notes:** Struwe: Analysis I/II, siehe https://people.math.ethz.ch/~struwe/skripten.html

**Literature:**
- K. Koenigsberger: Analysis I, Springer-Verlag
- R. Courant: Introduction to Calculus and Analysis, Springer Verlag
- V. Zorich: Mathematical Analysis I. Springer Verlag 2009
- W. Walter: Analysis I. Springer Verlag
- O. Forster: Analysis I. Vieweg Verlag
- J. Appell: Analysis in Beispielen und Gegenbeispielen. Springer Verlag

**Abstract:** Introduction to the theory of vector spaces for mathematicians and physicists including solutions of linear equations, linear transformations, determinants, eigenvalues and eigenvectors, bilinear forms, canonical forms for matrices, and selected applications, part I.

**Objective:** Mastering basic concepts of Linear Algebra

**Abstract:** This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.

**Objective:** Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.

**Abstract:** This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

**Objective:** The goal of this lecture is an algorithmically oriented introduction to programming.

**Abstract:** This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

**Objective:** Working Knowledge with functions of one complex variables; in particular applications of the residue theorem

**Literature:**
- Th. Gamelin: Complex Analysis. Springer 2001
- D. Salamon: "Funktionentheorie". Birkhauser, 2011. (In German)
- R. Remmert: Theory of Complex Functions. Springer Verlag

**Abstract:** Working Knowledge with functions of one complex variables; in particular applications of the residue theorem

**Literature:**
- Th. Gamelin: Complex Analysis. Springer 2001
- D. Salamon: "Funktionentheorie". Birkhauser, 2011. (In German)
402-2883-00L

**Abstract**

Physics III

Objective

A basic introduction to quantum and atomic physics, including basics of optics and equilibrium statistical physics. The course will focus on the relation of these topics to experimental methods and observations.

Content

Evidence for Quantum Mechanics: atoms, photons, photo-electric effect, Rutherford scattering, Compton scattering, de-Broglie waves.

Quantum mechanics: wavefunctions, operators, Schrodinger's equation, infinite and finite square well potentials, harmonic oscillator, hydrogen atoms, spin.

Atomic structure: Perturbation to basic structure, including Zeeman effect, spin-orbit coupling, many-electron atoms. X-ray spectra, optical selection rules, emission and absorption of radiation, including lasers.

Optics: Fermat's principle, lenses, imaging systems, diffraction, interference, relation between geometrical and wave descriptions, interferometers, spectrometers.

Statistical mechanics: probability distributions, micro and macrostates, Boltzmann distribution, ensembles, equipartition theorem, blackbody spectrum, including Planck distribution

**Lecture notes**

Lecture notes will be provided electronically during the course.

**Literature**


Statistical mechanics: "Statistical Physics", F. Mandl 0-471-91532-7

---

### Examination Block II

#### Number 402-2203-01L

**Title**

Classical Mechanics

**Type**

ECTS

Hours

Lecturers

**Abstract**

A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

---

### Third Year Compulsory Courses

#### Number 402-0205-00L

**Title**

Quantum Mechanics I

**Type**

ECTS

Hours

Lecturers

**Abstract**

Introduction to non-relativistic single-particle quantum mechanics. In particular, the basic concepts of quantum mechanics, such as the quantisation of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of symmetries will be discussed. Basic phenomena will be analysed and illustrated by generic examples.

**Objective**

Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, Dirac-notation, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.

**Content**

Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, density matrices, Schrödinger-, Heisenberg-, Dirac-pictures, time reversal, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.

---

### Core Courses

#### Core Courses in Experimental Physics

#### Number 402-0263-00L

**Title**

Astrophysics I

**Type**

ECTS

Hours

Lecturers

**Abstract**

This introductory course will develop basic concepts in astrophysics as applied to the understanding of the physics of planets, stars, galaxies, and the Universe.

**Objective**

The course provides an overview of fundamental concepts and physical processes in astrophysics with the dual goals of: i) illustrating physical principles through a variety of astrophysical applications; and ii) providing an overview of research topics in astrophysics.

---

#### Number 402-0255-00L

**Title**

Introduction to Solid State Physics

**Type**

ECTS

Hours

Lecturers

**Abstract**

The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, electronic properties of insulators, metals, semiconductors, transport properties, magnetism, superconductivity.

**Objective**

Introduction to Solid State Physics.

**Content**

The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, thermal properties of insulators; metals (classical and quantum mechanical description of electronic states, thermal and transport properties of metals); semiconductors (bandstructure and n/p-type doping); magnetism, superconductivity.

**Literature**

A Manuscript is distributed.

**Lecture notes**

Ibach & Lüth, Festkörperphysik

C. Kittel, Festkörperphysik

Ashcroft & Mermin, Festkörperphysik

W. Känzig, Kondensierte Materie

**Prerequisites / notice**

Voraussetzungen: Physik I, II, III wünschenswert

---

### Core Courses in Theoretical Physics

#### Number 402-0205-00L

**Title**

Quantum Mechanics I

**Type**

ECTS

Hours

Lecturers

**Abstract**

The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, thermal properties of insulators; metals (classical and quantum mechanical description of electronic states, thermal and transport properties of metals); semiconductors (bandstructure and n/p-type doping); magnetism, superconductivity.
The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing

**Physics Lab I**

ECTS

This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available or if the proseminar is already overbooked.

**Introduction to non-relativistic single-particle quantum mechanics.** In particular, the basic concepts of quantum mechanics, such as the quantisation of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of symmetries will be discussed. Basic phenomena will be analysed and illustrated by generic examples.

**Abstract**

Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, Dirac-notation, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.

**Content**

Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, density matrices, Schrödinger-, Heisenberg-, Dirac-pictures, time reversal, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.

**Objective**

Students should learn how to perform a bit more complex experiments, analyze the data and interpret the results.

**Prerequisites / notice**

Enrol at most once in the course of the Bachelor programme.

**Number of participants limited to 24.**

**IMPORTANT: You may not enrol repeatedly in the course of the Bachelor programme.**

**Prerequisite:** "Advanced Physics Laboratory I" completed.

**Enrol at most once in the course of the Bachelor programme!**

**Abstract**

This laboratory course provides basic training of experimental skills. These are experimental design, implementation, measurement, data analysis and interpretation, as well as error analysis. Written manuals for the individual experiments are available.

**Objective**

Students should learn how to perform a bit more complex experiments, analyze the data and interpret the results.

**Proseminars, Experimental and Theoretical Semester Papers**

To organise a semester project take contact with one of the instructors.

Not all lecturers are directly eligible in myStudies if "Professors" is the required type of lecturers. In such cases please take contact with the Study Administration Office (http://www.phys.ethz.ch/phys/education/studiensekretariat/?lang=en).

**Number**

<table>
<thead>
<tr>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Physics Laboratory I</td>
<td>W</td>
<td>9</td>
<td>18P</td>
<td>C. Grab, T. M. Ihn</td>
</tr>
<tr>
<td>Advanced Physics Laboratory II</td>
<td>W</td>
<td>9</td>
<td>18P</td>
<td>C. Grab, T. M. Ihn</td>
</tr>
</tbody>
</table>

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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proseminar Theoretical Physics: Particle Physics at the Energy Frontier</td>
<td>W</td>
<td>9</td>
<td>4S</td>
<td>A. Lazopoulos</td>
</tr>
<tr>
<td>Experimental Semester Project in a Group of the Physics Department</td>
<td>W</td>
<td>9</td>
<td>18A</td>
<td>Professors</td>
</tr>
<tr>
<td>Advanced Solid State Physics Experiments</td>
<td>W</td>
<td>9</td>
<td>18P</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

**Abstract**

This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available or if the proseminar is already overbooked.

Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein.

**Prerequisites / notice**

Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit.

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**Prerequisites / notice**

The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.

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**Prerequisites / notice**

The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.
Abstract
Experiments in condensed matter physics. The work includes the planning, build-up, data taking and analysis, and interpretation of the experimental results.

Objective

Content

Lecture notes
n/a

Prerequisites / notice
Arbeiten in einer Forschungsgruppe sind besonders gut geeignet, die Studierenden mit aktuellen Forschungsthemen und mit moderner Instrumentierung bekannt zu machen.

402-0400-BSL
Advanced Quantum Electronics Experiments

W
9 credits
18P

Supervisors

Prof. Tilman Esslinger
Prof. Jérôme Faist
Prof. Rachel Grange
Prof. Jonathan Home
Prof. Atac Imamoglu
Prof. Steven Johnson
Prof. Ursula Keller

Abstract
Implementation of experiments in quantum electronics. Planning, design, realisation, evaluation, and interpretation of the experiments.

Content

402-0717-BSL
Particle Physics at PSI (Paul Scherrer Institute)

W
9 credits
18P

C. Grab

Abstract
During semester breaks 6-12 students stay for 3 weeks at PSI and participate in a hands-on course on experimental particle physics. A small real experiment is performed in common, including apparatus design, construction, running and data analysis. The course includes some lectures, but the focus lies on the practical aspects of experimenting.

Objective
Students learn all the different steps it takes to perform a complete particle physics experiment in a small team. They acquire skills to do this themselves in the team, including design, construction, data taking and data analysis.

402-0340-BSL
Medical Physics

W
9 credits
18P

A. J. Lomax, R. Müller, K. P. Prüssmann, M. Rudin

Abstract
In agreement with the lecturers a semester paper in the context of the topics discussed in the lectures can be written.

402-0240-00L
Advanced Physics Laboratory II

W
9 credits
18P

C. Grab, T. M. Ihn

Prerequisite: "Advanced Physics Laboratory I" completed.
Enrol at most once in the course of the Bachelor programme.

Abstract
This laboratory course provides basic experimental skill training for performing physics experiments, including: Implementation of physics experiments using an instruction manual. Planning, designing, realizing, analyzing, and interpreting experiments. Estimating measurement precision.

Objective
Students should learn how to perform a bit more complex experiments, analyze the data and interpret the results.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-PHYS.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability.

see GESS Compulsory Electives: Language Courses ETH/ZH

Additional Courses, Seminars and Colloquia

First or Second Year Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0351-00L</td>
<td>Astronomy</td>
<td>Z</td>
<td>2 credits</td>
<td>2V</td>
<td>H. M. Schmid, W. Schmutz</td>
</tr>
</tbody>
</table>

Abstract
An overview on the important topics in modern astronomy: planets, sun, stars, milky way, galaxies, and cosmology.

Objective
This lecture gives a general introduction to main topics in modern astronomy. The lecture provide a basis for the more advanced lectures in astrophysics.

Content
Planeten, Sonne, Sterne, Milchstrasse, Galaxien und Kosmologie.

Lecture notes
Kopien der Präsentationen werde zur Verfügung gestellt.

Literature
Der Neue Kosmos. A. Unsöld, B. Baschek, Springer.
Geometry

Z

3 credits

2V+1U

L. Halbeisen

Abstract

Im Mittelpunkt dieser Vorlesung steht die euklidische und die projektive Geometrie.

Objective


Content


Literature

Robin Hartshorne: "Geometry: Euclid and beyond", Springer Verlag

Eric Lord: "Symmetry and Pattern in Projective Geometry", Springer Verlag

Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0247-00L</td>
<td>Electronics for Physicists I (Analogue)</td>
<td>Z</td>
<td>4</td>
<td>2V+2P</td>
<td>R. Horisberger</td>
</tr>
</tbody>
</table>

Abstract

Passive elts, linear complex networks, transmission lines, simulation of analog circuits, semiconductor elts: diodes, bipolar and field-effect transistors, basic amplifier circuits, small signal analysis, differential amplifiers, noise in analog circuits, operational amplifiers, OTAs, gyrator circuits, feedback and stability in amplifiers, oscillators, ADCs and DACs, introduction in CMOS technology.

Content

Passive elements, linear complex networks, transmission lines, simulation of analog circuits (SPICE), semiconductor elements: diodes, bipolar and field-effect transistors, basic amplifier circuits, small signal analysis, differential amplifiers, noise in analog circuits, operational amplifiers, OTA's, gyrator circuits, feedback and stability in amplifiers, oscillators, ADC's and DAC's, introduction in CMOS technology. Practical exercises in small groups to the above themes complement the lectures.

Prerequisites / notice


Additional Courses (from Second Year Mathematics Bachelor)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2003-00L</td>
<td>Algebra I</td>
<td>Z</td>
<td>7</td>
<td>4V+2U</td>
<td>R. Pink</td>
</tr>
</tbody>
</table>

Abstract

Introduction and development of some basic algebraic structures - groups, rings, fields.

Objective

Introduction to basic notions and results of group, ring and field theory.

Content

Basic notions and examples of groups;
Subgroups, Quotient groups and Homomorphisms, Group actions and applications
Basic notions and examples of rings;
Ring Homomorphisms, ideals, and quotient rings, rings of fractions Euclidean domains, Principal ideal domains, Unique factorization domains
Basic notions and examples of fields;
Field extensions, Algebraic extensions, Classical straight edge and compass constructions

Literature

G. Fischer: Lehrbuch der Algebra, Vieweg Verlag
Karpfinger-Meyberg: Algebra, Spektrum Verlag
S. Bosch: Algebra, Springer Verlag
B.L. van der Waerden: Algebra I und II, Springer Verlag
A. Knapp: Basic Algebra, Springer Verlag

Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract

Research colloquium

Prerequisites / notice

Occasionally, talks may be delivered in German.

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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</tr>
</thead>
</table>

Abstract

Research colloquium

Objective

The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.
401-5330-00L  Talks in Mathematical Physics  

Abstract  Research colloquium  

402-0501-00L  Solid State Physics  

Abstract  Research colloquium  

402-0551-00L  Laser Seminar  

Abstract  Research colloquium  

402-0600-00L  Nuclear and Particle Physics with Applications  

Abstract  Research colloquium  

402-0893-00L  Particle Physics Seminar  

Abstract  Research colloquium  

402-0700-00L  Seminar in Elementary Particle Physics  

Abstract  Research colloquium  

402-0356-00L  Research Colloquium in Astrophysics  

Abstract  Research colloquium  

227-0980-00L  Seminar on Biomedical Magnetic Resonance  

Abstract  Research colloquium  

227-1043-00L  Neuroinformatics - Colloquia  

Abstract  Research colloquium  

227-1044-00L  Auditory Informatics  

Abstract  Research colloquium  

402-0396-00L  Recent Research Highlights in Astrophysics (University of Zurich)  

Abstract  Research colloquium  

Prerequisites / notice  Occasionally, talks may be delivered in German.

Objective  During the semester there is a colloquium every week. In general, colloquia are 20 minutes plus discussion and are given by local researchers. They inform the other members of the Institute of Astronomy about their current work, results, problems and plans. Guests are always welcome.

Ph.D. students are expected to give a first research colloquium within their first years of their graduate time, another colloquium in their third year, and their doctoral exam talk before or after the exam. Other members of the institute are also invited to give talks. The goals are:

- keep other members of the institute oriented on current research
- test new ideas within the institute before going outside
- train students to give scientific talks

Objective  The colloquium in Neuroinformatics is a series of lectures given by invited experts. The lecture topics reflect the current themes in neurobiology and neuromorphic engineering that are relevant for our Institute.

Objective  The goal of these talks is to provide insight into recent research results. The talks are not meant for the general public, but really aimed at specialists in the field.

Content  The topics depend heavily on the invited speakers, and thus change from week to week.

All topics concern neural computation and their implementation in biological or artificial systems.

Prerequisites / notice  On request the "Lehrsprache" may be changed to German.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0811-00L</td>
<td>Programming Techniques for Scientific Simulations I</td>
<td>W</td>
<td>5 credits</td>
<td>4G</td>
<td>M. Troyer</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained.</td>
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<tr>
<td>402-0713-00L</td>
<td>Astro-Particle Physics I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>A. Biland</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture gives an overview of the present research in the field of Astro-Particle Physics, including the different experimental techniques. In the first semester, main topics are the charged cosmic rays including the antimatter problem. The second semester focuses on the neutral components of the cosmic rays as well as on some aspects of Dark Matter.</td>
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<tr>
<td>Objective</td>
<td>Successful students know: - experimental methods to measure cosmic ray particles over full energy range - current knowledge about the composition of cosmic ray - possible cosmic acceleration mechanisms - correlation between astronomical object classes and cosmic accelerators - information about our galaxy and cosmology gained from observations of cosmic ray</td>
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<tr>
<td>Content</td>
<td>First semester (Astro-Particle Physics I): - definition of 'Astro-Particle Physics' - important historical experiments - chemical composition of the cosmic rays - direct observations of cosmic rays - indirect observations of cosmic rays - 'extended air showers' and 'cosmic muons' - 'knee' and 'ankle' in the energy spectrum - the 'anti-matter problem' and the Big Bang - 'cosmic accelerators'</td>
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<tr>
<td>Literature</td>
<td>See lecture home page: <a href="http://ihp-lx2.ethz.ch/AstroTeilchen/">http://ihp-lx2.ethz.ch/AstroTeilchen/</a></td>
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<tr>
<td>402-0737-00L</td>
<td>Energy and Environment in the 21st Century (Part I)</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>M. Dittmar</td>
</tr>
<tr>
<td>Abstract</td>
<td>The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.</td>
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<tr>
<td>Objective</td>
<td>Scientists and espially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate. The lecture is for students which are interested participate in a rational and responsible debate about the energy problem of the 21. century.</td>
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<tr>
<td>Content</td>
<td>Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses? - Energy conservation and the first and second law of thermodynamics - Fossil fuels (our stored energy resources) and their use. - Burning fossil fuels and the physics of the greenhouse effect. - physics basics of nuclear fission and fusion energy - controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle. - Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods. - The problems with nuclear fusion and the ITER project. - Nuclear fusion and fission: &quot;exotic&quot; ideas. - Hydrogen as an energy carrier: ideas and limits of a hydrogen economy. - new clean renewable energy sources and their physical limits (wind, solar, geothermal etc) - Energy perspectives for the next 100 years and some final remarks</td>
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<tr>
<td>Literature</td>
<td>many more details (in english and german) here: <a href="http://ihp-lx2.ethz.ch/energy21/">http://ihp-lx2.ethz.ch/energy21/</a></td>
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</tbody>
</table>
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, and protein
K. A. Martin
Introduction to Neuroinformatics
M. Tinkham "Introduction to Superconductivity"
R. Chitra

The goal of this course is to introduce the foundations of quantum information theory. It starts with a brief introduction to the mathematical
Physics in Medical Research: From Atoms to Cells

The course gives an insight into the notion of information and its relevance to physics and, in particular, quantum mechanics. It also serves

Quantum Information Theory
W 8 credits 2V+1U R. Renner

Objective
The course provides an introduction to superconductivity, covering both experimental as well as theoretical aspects. The following
Superconductivity
W 6 credits 2V+1U R. Chitra

Objective
Introduction to the most important aspects of superconductivity.

Content
This lecture course provides an introduction to superconductivity, covering both experimental as well as theoretical aspects. The following

Literature
M. Tinkham "Introduction to Superconductivity"
P. G. de Gennes "Superconductivity Of Metals And Alloys"
A. A. Abrikosov "Fundamentals of the Theory of Metals"

Prerequisites / notice
The preceding attendance of the scheduled lecture courses Introduction to Solid State Physics and Quantum Mechanics I are expected.

Physics in Medical Research: From Atoms to Cells
W 6 credits 2V+1U B. K. R. Müller

Abstract
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For

Objective
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning
tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena
are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

Introduction to Neuroinformatics
W 6 credits 2V+1U K. A. Martin, M. Cook, V. Mante, M. Pfeiffer

Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

**Content**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>ECTS</th>
<th>Hours</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>401-3531-00L</td>
<td>Differential Geometry I</td>
<td>10</td>
<td>4V+1U</td>
<td>M. Burger</td>
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<tr>
<td>Abstract</td>
<td>This course is an introduction to differential and riemannian geometry.</td>
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<tr>
<td>Objective</td>
<td>The aim is to lead students from a reasonable knowledge of advanced calculus, basic knowledge of general topology and solid knowledge of linear algebra to fundamental knowledge of differentiable manifolds and their basic tools. Riemannian geometry, some basic Lie theory, and de Rham cohomology will be developed as applications.</td>
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</tr>
<tr>
<td>Literature</td>
<td>W.Boothby “An introduction to differentiable manifolds and Riemannian geometry”</td>
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<td></td>
<td>J.M.Lee “Introduction to smooth manifolds”</td>
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<td></td>
<td>M.P. Do Carmo “Riemannian Geometry”</td>
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<tbody>
<tr>
<td>401-3461-00L</td>
<td>Functional Analysis I</td>
<td>10</td>
<td>4V+1U</td>
<td>D. A. Salamon</td>
</tr>
<tr>
<td>Abstract</td>
<td>Baire category; Banach and Hilbert spaces, bounded linear operators; Three Fundamental Principles: Uniform Boundedness, Open Mapping/Closed Graph, Hahn-Banach; Convexity; Dual Spaces: weak and weak* topologies, Banach-Alaoglu, reflexive spaces; Ergodic Theorem; compact operators and Fredholm theory, Closed Image Theorem; Spectral theory, self-adjoint operators.</td>
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<tr>
<td>Literature</td>
<td>Lecture Notes on “Functional Analysis” by D.A. Salamon</td>
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<tbody>
<tr>
<td>401-3601-00L</td>
<td>Probability Theory</td>
<td>10</td>
<td>4V+1U</td>
<td>A.S. Sznitman</td>
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<tr>
<td>Abstract</td>
<td>Basics of probability theory and the theory of stochastic processes in discrete time</td>
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<tr>
<td>Objective</td>
<td>This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<td>Content</td>
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<td></td>
<td>H. Bauer, Probability Theory, de Gruyter 1996</td>
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<td></td>
<td>J. Jacod and P. Protter, Probability essentials, Springer 2004</td>
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<td>A. Klenke, Wahrscheinlichkeitstheorie, Springer 2006</td>
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<td>D. Williams, Probability with martingales, Cambridge University Press 1991</td>
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<th>ECTS</th>
<th>Hours</th>
<th>Type</th>
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<tbody>
<tr>
<td>401-3621-00L</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>10</td>
<td>4V+1U</td>
<td>S. van de Geer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers the basics of inferential statistics.</td>
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**Physics Bachelor - Key for Type**

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

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<td>Prerequisites / notice</td>
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<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
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<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<tr>
<td></td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td>- Getting to know intelligence tests</td>
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<td></td>
<td>- Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Abstract</td>
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<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td>Objective</td>
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<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td>- Understand and critically examine information from scientific journals and media</td>
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<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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### Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0910-00L</td>
<td>Physics Didactics I: Special Didactics of Physics Teaching</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>M. Mohr</td>
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<tr>
<td></td>
<td>Limited number of participants.</td>
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<td></td>
<td>Further information is available from the lecturer via email: <a href="mailto:mamohr@ethz.ch">mamohr@ethz.ch</a></td>
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<tr>
<td></td>
<td>Simultaneous enrolment in Introductory Internship Physics</td>
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<td></td>
<td>- course 402-0920-00L - is compulsory for Teaching Diploma PhD</td>
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<tr>
<td></td>
<td>Objective</td>
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</tbody>
</table>
### Content

- **Thematic Schwerpunkte**
- Fachspezifisches: Sachstrukturen der gängigen Unterrichtsthemen, Alltagsbezüge, Fehlvorstellungen, Demonstrations- und Schülerexperimente, Arbeitsmittel zu physikalischen Themen des Grund- und Schwerpunktuunterrichts
- Einsatz verschiedener Unterrichtsmaterialien: Experimente, Computer, Taschenrechner, Video, Simulation
- Unterrichtsformen: Lernaufgabe, Werkstatt, Puzzle, Projekt, Gruppenarbeit, Praktikum

### Lecture notes

- Folien und weitere Unterlagen werden zur Verfügung gestellt
- wird während der Veranstaltung mitgeteilt

### Literature

- Die Veranstaltung ist zusammen mit dem Einführungspraktikum zu belegen

### Prerequisites / notice

#### 402-0915-00L

**Teaching Internship Including Examination Lessons**

- **O** 4 credits
- **9P** M. Mohr

**Physics**

- Teaching Internship for TC and Teaching Diploma Physics as Minor Subject.
- Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.

**Abstract**

- Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

**Objective**

- The objective is for the students:
  - to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
  - to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**

- Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäß Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die fachliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

**Lecture notes**

- Wird von der Praktikumslehrperson bestimmt.

**Literature**

- Wird dokument: schriftliche Vorbereitung für Prüfungslektionen.

#### 402-0917-00L

**Mentored Work Subject Didactics Physics A**

- **O** 2 credits
- **4A** G. Schiltz, A. Vaterlaus, C. Wagner

**Teaching Diploma and Teaching Diploma Physics as Minor Subject.**

**Abstract**

- In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**

- The objective is for the students:
  - to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
  - to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**

- Thematic Focus

**Methods**

- With the help of the mentor the students individually work on a topic and write a thesis about it.

### Specialized Courses in Respective Subject with Educational Focus

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0737-00L</td>
<td>Energy and Environment in the 21st Century (Part I)</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>M. Dittmar</td>
</tr>
</tbody>
</table>

**Abstract**

- The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

**Objective**

- Scientists and especially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

- The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21st century.
Content

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: "exotic" ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks

Lecture notes

many more details (in english and german) here:

http://ihp-lx2.ethz.ch/energy21/

Literature


Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize:

it never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

402-0922-00L  Mentored Work Specialised Courses in Physics with an Educational Focus A

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Physics for TC and Teaching Diploma.

Abstract

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

Objective

Practice in the explanation of complex topics in physics as the core competence of the teaching profession

Content

Improvement of the physics education by providing attractive recent topics with regard to future curricular decisions and the public view of physics

Choice of topic by individual arrangement

402-0944-00L  Science in School (Current Topics for the Classroom)

Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.

Abstract

Kennenlernen und erarbeiten (Übungen) von Unterrichtssequenzen zu modernen Themen der Physik.

Lecture notes

Underlagen werden verteilt.

Literature

Wird angegeben.

Prerequisites / notice


Physics TC - Key for Type

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

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**
- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
### Physics as First Subject

#### Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects  ▶ W</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td>Abstract: This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<td></td>
<td>Objective: - Get to know cognitively activating instructions in MINT subjects - Get information about recent literature on learning and instruction</td>
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<td></td>
<td>Prerequisites / notice: Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence  ▶ W</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>Abstract: The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td>Objective: - Understanding of research methods used in the empirical human sciences - Getting to know intelligence tests - Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science  ▶ W</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td>Abstract: Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td></td>
<td>Objective: - Understand research methods used in the empirical educational sciences - Understand and critically examine information from scientific journals and media - Understand pedagogically relevant findings from the empirical educational sciences</td>
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<td>Number of participants limited to 20.</td>
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<td>The successful completion of both course no. 851-0240-00L &quot;Menschliches Lernen (EW 1)&quot; and course no. 851-0238-01L &quot;Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)&quot; is a necessary prerequisite for this course.</td>
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<td></td>
<td>Abstract: In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<td>Objective: The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)</td>
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<td>Learning goals include: - Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples. - Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction. - Participants can design and conduct a study that is relevant for answering their research question. - Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.</td>
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Subject Didactics in Physics

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0910-00L</td>
<td>Physics Didactics I: Special Didactics of Physics Teaching</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>M. Mohr</td>
</tr>
<tr>
<td></td>
<td>Further information is available from the lecturer via email:</td>
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<tr>
<td></td>
<td><a href="mailto:mamohr@ethz.ch">mamohr@ethz.ch</a></td>
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</tr>
<tr>
<td></td>
<td>Simultaneous enrolment in Introductory Internship Physics</td>
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</tr>
<tr>
<td></td>
<td>- course 402-0920-00L - is compulsory for Teaching Diploma Physic</td>
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</tbody>
</table>

Objective
Die Studierenden verfügen über fachdidaktisches Grundwissen für den Physikunterricht an einer Mittelschule. Sie können eigene Lektionen unter Berücksichtigung der vielfältigen Rahmenbedingungen planen, durchführen und evaluieren. Sie reflektieren ihren Unterricht und sind bestrebt, ihn didaktisch und pädagogisch weiter zu entwickeln.

Die Studierenden kennen die Einsatzmöglichkeiten, Chancen und Schwierigkeiten verschiedener Unterrichtsmethoden und Hilfsmittel. Sie können die Eignung von Unterrichtsformen im Hinblick auf eine Lernsituation beurteilen. Sie bermühen sich in ihrem Unterricht, geeignete Methoden und Medien angepasst an die Klasse und das Thema einzusetzen.


Content
Thematische Schwerpunkte
Lektionsplanung und durchführung; Lehrplan, Stundentafel, Zeitbudget, Artikulationsschema, Berücksichtigung von Vorwissen, Übungs- und Hausaufgaben, Prüfungen und Noten, Verständlichkeit von Lehrtexten, Weiterbildung, Unterrichtsevaluation
Fachspezifisches; Sachstrukturen der gängigen Unterrichtsthemen, Alltagsbezüge, Fehlvorstellungen, Demonstrations- und Schülerexperimente, Arbeitsmittel zu physikalischen Themen des Grundlagen- und Schwerpunkunterrichts
Einsatz verschiedener Unterrichtsmaterialien: Experimente, Computer, Taschenrechner, Video, Simulation
Unterrichtsformen: Lernaufgabe, Werkstatt, Puzzle, Projekt, Gruppenarbeit, Praktikum
Lernformen
Interaktive Lehr-Lernveranstaltung mit Vorträgen und Demonstrationen des Dozenten, studentischer Einzel- und Kleingruppenarbeit, kurzen Präsentationen der Studierenden, Vertiefung der Inhalte durch Bearbeitung von Aufträgen ausserhalb der Kontakstunden

Lecture notes
Foliens und weitere Unterlagen werden zur Verfügung gestellt

Literature
Die Veranstaltung ist zusammen mit dem Einführungspraktikum zu belegen

402-0917-00L Mentored Work Subject Didactics Physics A

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0917-00L</td>
<td>Mentored Work Subject Didactics Physics for TC, Teaching Diploma and Teaching Diploma Physics as Minor Subject</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>G. Schiltz, A. Vaterlaus, C. Wagner</td>
</tr>
</tbody>
</table>

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Thematic Focus
The topics of the mentored work are mostly chosen from the high school curriculum.

Methods
With the help of the mentor the students individually work on a topic and write a thesis about it.

402-0918-00L Mentored Work Subject Didactics Physics B

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0918-00L</td>
<td>Mentored Work Subject Didactics Physics for TC and Teaching Diploma</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>G. Schiltz, A. Vaterlaus, C. Wagner</td>
</tr>
</tbody>
</table>

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
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- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Focus of conten
The topics of the mentored work are mostly chosen from the high school curriculum.

Methods
With the help of the mentor the students individually work on a topic and write a thesis about it.

Professional Training in Physics

Professional Training (First Subject)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0920-00L</td>
<td>Introductory Internship Physics Teaching</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>M. Mohr</td>
</tr>
</tbody>
</table>

Abstract
During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-
based teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

Wird von der Praktikumslehrperson bestimmt.

Teaching Internship Physics

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

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

Teaching Internship for students upgrading TC to Teaching Diploma


Teaching Internship Physics II

Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können einen gegebenen Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbare (Fach-)Wissen zu erwerben.

Teaching Internship Physics for Teaching Diploma


Teaching Internship Physics for Teaching Diploma

This is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.

Wird von der Praktikumslehrperson bestimmt.

Teaching Internship Physics for Teaching Diploma

The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

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

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Wird von der Praktikumslehrperson bestimmt.

Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

Nach Abschluss der übrigen Ausbildung.

 множество Professional Training (Two Subjects in One-Step Procedure)

The programme "Teaching Diploma, Two Subjects in One-Step Procedure" will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0891-00L</td>
<td>Teaching Internship Physics ■</td>
<td>O</td>
<td>6 credits</td>
<td>13P</td>
<td>M. Mohr</td>
</tr>
</tbody>
</table>

**Abstract**

In the final phase of their training, students have to apply and test the insights, abilities and skills they have acquired. They spend 3-5 weeks in an educational institution, during which time they observe 10 lessons and teach 30 lessons independently. The Teaching Internship is complemented by 10 further observed lessons, which are integrated into the Mentored Work in Subject Didactics.

**Objective**

Die Studierenden können die Bedeutung von Unterrichtsthemen unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbare (Fach-)Wissen zu erwerben.

**Content**


Für Studierende, die ab FS 2014 in das Lehre diplom eingetreten sind, ist das Fachdidaktikpraktikum Physik obligatorisch. Alle weiteren Lehrveranstaltungen sind individuell wählbar.

Studierende, die vor dem FS 2014 in das Lehre diplom eingetreten sind, müssen entweder die mentorierte Arbeit oder das jeweils im FS angebotene Fachdidaktikpraktikum Physik als obligatorische Lehrveranstaltung absolvieren. Selbstverständlich können auch beide Lehrveranstaltungen absolviert werden.

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<tr>
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<tbody>
<tr>
<td>402-0737-00L</td>
<td>Energy and Environment in the 21st Century (Part I)</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>M. Dittmar</td>
</tr>
</tbody>
</table>

**Abstract**

The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

**Objective**

Scientists and espially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21. century.

**Content**

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

 Burning fossil fuels and the physics of the greenhouse effect.

physics basics of nuclear fission and fusion energy

controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: "exotic" ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

new clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks
Lecture notes
many more details (in english and german) here:
http://ihp-lx2.ethz.ch/energy21/

Literature
Die Energiefrage - Bedarf und Potentiale, Nutzung, Risiken und Kosten:
Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice
Science promised us truth, or at least a knowledge
of such relations as our intelligence can seize:
it never promised us peace or happiness
Gustave Le Bon

Physicists learned to realize that whether they like a theory or
they don't like a theory is not the essential question.
Rather, it's whether or not the theory gives predictions that agree with experiment.
Richard Feynman, 1985

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<tr>
<td>402-0944-00L</td>
<td>Science in School (Current Topics for the Classroom)</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>C. Wagner, A. Vaterlaus</td>
</tr>
<tr>
<td>Content</td>
<td>Kennenlernen und erarbeiten (Übungen) von Unterrichtssequenzen zu modernen Themen der Physik.</td>
<td></td>
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<td>Lecture notes</td>
<td>Unterlagen werden verteilt.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Wird angegeben.</td>
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<td>Prerequisites / notice</td>
<td>Der Besuch der FD1 sowie der FD2 in Physik wird vorausgesetzt. Zu den Themen der Vorlesung können mentorierte Arbeiten verfasst werden.</td>
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<tr>
<td>402-0922-00L</td>
<td>Mentored Work Specialised Courses in Physics with an Educational Focus A</td>
<td>W</td>
<td>2 credits</td>
<td>4A</td>
<td>G. Schiltz, A. Vaterlaus, C. Wagner</td>
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<tr>
<td>Abstract</td>
<td>In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.</td>
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<td>Content</td>
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<tr>
<td>402-0923-00L</td>
<td>Mentored Work Specialised Courses in Physics with an Educational Focus B</td>
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Compulsory Elective Courses

Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

Teaching Diploma in 2 Subjects in One-Step Procedure:
a) the course 402-0904-00L "Professional Exercises: Experiments in physics teaching" (takes place in Spring Semester only) must be completed within the category Compulsory Elective Courses;
b) courses from the category Compulsory Elective Courses of the Minor Subject may also be selected;
c) courses from the category Specialized Courses in the Respective Subject, either of the Major or the Minor Subject, may also be selected.

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Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

Controlled nuclear fission energy today, the different types of
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Nuclear reactor accidents and the consequences,
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Gustave Le Bon

Physicists learned to realize that whether they like a theory or
they don't like a theory is not the essential question.
Rather, it's whether or not the theory gives predictions that agree with experiment.
Richard Feynman, 1985

402-0944-00L  Science in School (Current Topics for the Classroom) W 2 credits 2G C. Wagner, A. Vaterlaus

Enrolment in Physics Didactics I (402-0910-00L) and
Physics Didactics II (402-0910-00L) is mandatory.

Content
Kennenlernen und erarbeiten (Übungen) von Unterrichtsssequenzen zu modernen Themen der Physik.

Lecture notes
Unterlagen werden verteilt.

Literature
Wird angegeben.

Prerequisites /
notice
Der Besuch der FD1 sowie der FD2 in Physik wird vorausgesetzt. Zu den Themen der Vorlesung können mentorierte Arbeiten verfasst
werden.

252-0855-00L  Computer Science in Secondary School Mathematics W 4 credits 3G J. Hromkovic, G. Serafini

Abstract
The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the
tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high
school mathematics classes.

Objective
The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to
contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of
computer science in mathematics classes.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this
understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on
to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior
knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written
way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding
German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching
materials.
Content

The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

The course covers the didactics of logic, of cryptography, of finite state automata, of computability and of the introduction to programming.

The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

In a semester exercise, the students develop an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lecture notes

Lecturer and Teaching Methods

Literature


see Compulsory Elective Courses Teaching Diploma

Physics as Second Subject

Subject Didactics in Physics

Number

Title

Type ECTS

Hours

Lecturers

402-0910-00L

Physics Didactics I: Special Didactics of Physics Teaching

Limited number of participants.

Further information is available from the lecturer via email: mamohr@ethz.ch

Simultaneous enrolment in Introductory Internship Physics - course 402-0920-00L - is compulsory for Teaching Diploma Physic

Objective

Die Studierenden verfügen über fachdidaktisches Grundwissen für den Physikunterricht an einer Mittelschule. Sie können eigene Lektionen unter Berücksichtigung der vielfältigen Rahmenbedingungen planen, durchführen und evaluieren. Sie reflektieren ihren Unterricht und sind bestrebt, ihn didaktisch und pädagogisch weiter zu entwickeln.

Die Studierenden kennen die Einsatzmöglichkeiten, Chancen und Schwierigkeiten verschiedener Unterrichtsmethoden und Hilfsmittel. Sie können die Eignung von Unterrichtsformen im Hinblick auf eine Lernsituation beurteilen. Sie bemühen sich in ihrem Unterricht, geeignete Methoden und Medien angepasst an die Klasse und das Thema einzusetzen.


Content

Themenische Schwerpunkte


Fachspezifisches; Sachstruktur der gängigen Unterrichtsthemen, Alltagsbeziehungen, Demonstrations- und Schülerexperimente, Arbeitsmittel zu physikalischen Themen des Grundlagen- und Schwerpunktsunterrichts

Einsatz verschiedener Unterrichtsmaterialien: Experimente, Computer, Taschenrechner, Video, Simulation

Unterrichtsformen: Lernaufgabe, Werkstatt, Puzzle, Projekt, Gruppenarbeit, Praktikum

Lernformen

Interaktive Lehr-Lernveranstaltung mit Vorträgen und Demonstrationen des Dozenten, studentischer Einzel- und Kleingruppenarbeit, kurzen Präsentationen der Studierenden, Verifizierung der Inhalte durch Bearbeitung von Aufträgen ausserhalb der Kontaktstunden

Lecture notes

Literature

Prerequisites / notice

Mentored Work Subject Didactics Physics A

Mentored Work Subject Didactics in Physics for TC, Teaching Diploma and Teaching Diploma as Minor Subject.

Abstract

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective

The objective is for the students:

- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content

Thematic Focus

The topics of the mentored work are mostly chosen from the high school curriculum.

Methods

With the help of the mentor the students individually work on a topic and write a thesis about it.

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

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

Content

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäß Anleitung und reichen sie bis um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature
Wird von der Praktikumslehrperson bestimmt.
Core Courses

One Core Course in Experimental or Theoretical Physics from Physics Bachelor is eligible; however, this Core Course from Physics Bachelor cannot be used to compensate for the mandatory Core Course in Experimental or Theoretical Physics.

For the category assignment keep the choice "no category" and take contact with the Study Administration Office (www.phys.ethz.ch/phys/education/studiensekretariat/?lang=en) after having received the credits.

Core Courses in Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>402-0861-00L</td>
<td>Statistical Physics</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>M. Sigrist</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory. In a more advanced part Bose-Einstein condensation, general mean field theory and critical phenomena will be addressed. Finally also various aspects of linear response theory will be discussed.</td>
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<tr>
<td>Objective</td>
<td>This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes will be provided.</td>
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</tr>
<tr>
<td>Literature</td>
<td>No specific book is used for the course. Relevant literature will be cited in the course.</td>
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<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>G. Isidori</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity. Topics include: - Relativistic quantum mechanics - Quantisation of bosonic and fermionic fields - Interactions in perturbation theory - Scattering processes and decays - Radiative corrections</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.</td>
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<tr>
<td>402-0830-00L</td>
<td>General Relativity</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>M. Gaberdiel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.</td>
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Core Courses: Experimental Physics

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>402-0257-00L</td>
<td>Advanced Solid State Physics</td>
<td>W</td>
<td>10</td>
<td>3V+2U</td>
<td>A. Zheludev</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is an extension of the introductory course on solid state physics. The purpose of this course is to learn to navigate the complex collective quantum phases, excitations and phase transitions that are the dominant theme in modern solid state physics. The emphasis is on the main concepts and on specific experimental examples, both classic ones and those from recent research.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The goal is to study how novel phenomena emerge in the solid state.</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Today’s challenges and opportunities in Solid State Physics

- Phase transitions and critical phenomena
  - Main concepts: coherence length, symmetry, order parameter, correlation functions, generalized susceptibility
  - Bragg-Williams mean field theory
  - Landau theory of phase transitions
  - Fluctuations in Landau theory
  - Critical exponents: significance, measurement, inequalities, equalities
  - Scaling and hyperscaling
  - Universality
  - Critical dynamics
  - Quantum phase transitions and quantum criticality

- Fermi surface instabilities
  - The concept of the Landau Fermi liquid in metals
  - Kohn anomalies
  - Charge density waves
  - Metallic ferromagnets and half-metals
  - Spin density waves

- Magnetism of insulators
  - Magnetic interactions in solids and the spin Hamiltonian
  - Magnetic structures and phase transitions
  - Spin waves
  - Quantum magnetism

- Electron correlations in solids
  - Mott insulating state
  - Phases of the Hubbard model
  - Layered cuprates (non-superconducting properties)

Lecture notes
The printed material for this course involves: (1) a self-contained script, distributed electronically at semester start. (2) experimental examples (Power Point slide-style) selected from original publications, distributed at the start of every lecture.

Literature
A list of books will be distributed. Numerous references to useful published scientific papers will be provided.

Prerequisites / notice
This course is for students who like to be engaged in active learning. The "exercise classes" are organized in a non-traditional way: following the idea of "less is more", we will work on only about half a dozen topics, and this gives students a chance to take a look at original literature (provided), and to get the grasp of a topic from a broader perspective.

Students report back that this mode of "exercise class" is more satisfying than traditional modes, even if it does not mean less effort.
Electives

Electives: Physics and Mathematics

Selection: Solid State Physics

<table>
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<tr>
<td>402-0526-00L</td>
<td>Ultrafast Processes in Solids</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>Y. M. Acremann, A. Vaterlaus</td>
</tr>
</tbody>
</table>

Abstract
Ultrafast processes in solids are of fundamental interest as well as relevant for modern technological applications. The dynamics of the lattice, the electron gas as well as the spin system of a solid are discussed. The focus is on time resolved experiments which provide insight into pico- and femtosecond dynamics.

Objective
After attending this course you understand the dynamics of essential excitation processes which occur in solids and you have an overview over state of the art experimental techniques used to study fast processes.

Content
1. Experimental techniques, an overview
2. Dynamics of the electron gas
   2.1 First experiments on electron dynamics and lattice heating
   2.2 The finite lifetime of excited states
   2.3 Detection of lifetime effects
   2.4 Dynamical properties of reactions and adsorbents
3. Dynamics of the lattice
   3.1 Phonons
   3.2 Non-thermal melting
4. Dynamics of the spin system
   4.1 Laser induced ultrafast demagnetization
   4.2 Ultrafast spin currents generated by lasers
   4.3 Landau-Lifschitz-Dynamics
   4.4 Laser induced switching
5. Correlated materials

Lecture notes will be distributed

Literature relevant publications will be cited

Prerequisites / notice
The lecture can also be followed by interested non-physics students as basic concepts will be introduced.

This lecture is complementary to the lecture on "ultrafast methods for solid state physics" of the spring semester. Both lectures can be attended independently. The focus of this lecture is on the physical processes whereas the focus of the "ultrafast methods for solid state physics" lecture is on the experimental techniques.

402-0535-00L | Introduction to Magnetism | W    | 6 credits | 2V+1U | D. Pescia, A. Vindigni |

Abstract
Atomic paramagnetism and diamagnetism, intra- and inter-atomic exchange, Stoner model, RKKY exchange interaction, Ising and Heisenberg models, the mean field approximation, spin waves, magnetic phase transition, domains and domain walls, dynamical aspects

Content
The lecture "Introduction to Magnetism" is the regular course on Magnetism for the Master curriculum of the Department of Physics of ETH Zurich. With respect to the similar lecture course in previous semesters we have decided that we need to insist on the fundamental aspects of magnetism -- the Quantum mechanical aspects on one side and the statistical physics aspects on the other, which are often not comprehensively spelled out in conventional lectures on solid state physics.

The preliminary Content of the lecture in this semester is the following:
- Magnetism in Atoms (the role of magnetism in classical physics, the quantum mechanics of atoms, exchange interaction)
These two chapters will be given by D. Pescia. They will give, for instance, the opportunity of revising with concrete examples the subjects related to spin physics that have been treated at a theoretical level in Quantum Mechanics I and Quantum Mechanics II.
- Magnetic order at finite temperatures (Ising and Heisenberg models, mean field approximation, phase transitions, low-dimensional magnetism)
- Topological excitations (domains, domain walls, magnetic anisotropy, dipolar interaction)
- Spin Physics in the time Domain
These three Chapters will be given by A. Vindigni and are an essential introduction to more specialized Topics given in selected lectures, such as the one by R. Allenspach in FS16.

Lecture notes A manuscript is made available.

Prerequisites / notice
The former title of this course unit was "Fundamental Aspects of Magnetism". This lecture insists on the fundamental aspects -- Quantum physics and statistical physics of magnetism. Applications to nanoscale magnetism will be discussed within this fundamental Approach.

402-0595-00L | Semiconductor Nanostructures | W    | 6 credits | 2V+1U | T. M. Ihn |

Abstract
The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.

Objective
At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:
1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots

Semiconductor Materials: Fundamentals and Fabrication

This course gives an introduction into the fundamentals of semiconductor materials. The main focus is on state-of-the-art fabrication and characterization methods. The course will be continued in the spring term with a focus on applications.

Objective
Basic knowledge of semiconductor physics and technology. Application of this knowledge for state-of-the-art semiconductor device processing.

Content

Lecture notes
https://moodle-app2.let.ethz.ch/course/view.php?id=1044

Neutron Scattering in Solid State Physics

Introduction to neutron scattering: quantum-mechanical description in terms of correlation functions. Principles of neutron instrumentation. Applications to basic problems of solid state physics: diffraction from crystals, lattice dynamics, scattering by liquids, magnetic structures and magnetic excitations.

Objective
Derivation and comprehension of neutron scattering cross sections, principles of neutron instrumentation, and applications (lecture and exercises) to basic problems of solid state physics: static and dynamics of condensed matter, magnetic structures as well as magnetic excitations.
1. Introduction

2. Fundamentals of neutron scattering
2.1 Introduction to the theory of thermal neutron scattering


Prerequisites / notice

Former course title "Neutron Scattering in Condensed Matter Physics I"

Abstract

The course aims to give students the ability to follow and explain on a conceptual level the ways in which accelerator-based facilities (photon, neutron and muon sources) enable the study of various problems in a wide range of fields, including for example quantum information theory, solid state dynamics in superconductors and low dimensional systems, quantum phase transitions, as well as structural biology.

Content

The course will discuss several current examples of research using accelerator facilities highlighting different technologies and their applications. Specific attention will be given to x-ray spectroscopy and scattering experiments conducted at synchrotrons and x-ray Free Electron Lasers, as well as neutron scattering experiments at spallation sources and muon spin rotation.

Prerequisites / notice

Prerequisites: Solid State Physics, Quantum Mechanics

6 credits

402-0505-00L

Physics in the Smartphone

W

6 credits

3G

B. Batlogg

Abstract

Physics in today's high-tech smartphone. Examples: network topology and scratch proof glass, spin-orbit coupling - brighter displays, GPS and general theory of relativity, electromagnetic response of matter (transparent metals for displays, GPS signal propagation), light-field cameras, CCD and CMOS light sensors, physics stops Moore's law, meta-materials for antennas, MEMS sensor physics, etc.

Objective

Students recognize and appreciate the enormous impact "physics" has on today's high tech world. Abstract concepts, old and recent, encountered in the lectures are implemented and present all around us.

Content

We explore how traditional and new physics concepts and achievements make their way into today's ubiquitous high-tech gadget: the smartphone.

Examples of topics include:

- network topology and scratch proof Gorilla glass
- spin-orbit coupling makes for four times brighter displays
- no GPS without general theory of relativity
- electromagnetic response of matter (transparent metals for displays, GPS signal propagation in the atmosphere)
- light-field cameras replacing CCD and CMOS light sensors
- physical limitations to IC scaling: the end of "Moore's law"
- meta-materials for antennas

Lecture notes

The presentation material and original literature will be distributed weekly.

Prerequisites / notice

PLEASE NOTE: STARTING DATE WILL BE Tuesday, Sept. 22. SECOND WEEK OF SEMESTER.

Basic physics lectures and introduction to solid state physics are expected.

This is a "3 hour" course, with two hours set for Tuesday morning "9-11 H"nggerber time", and the third one to be set at the beginning of the semester.

* Special lecture: phase transitions in ice

* Special lecture: magnetism in 1 dimension

>> Selection: Quantum Electronics

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<tbody>
<tr>
<td>402-0464-00L</td>
<td>Optical Properties of Semiconductors</td>
<td>W</td>
<td>8 credits</td>
<td>2V+2U</td>
<td>J. Faist, A. Imamoglu</td>
</tr>
<tr>
<td>402-0402-00L</td>
<td>Ultrafast Laser Physics</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>L. P. Gallmann</td>
</tr>
</tbody>
</table>

Abstract

This course presents a comprehensive discussion of optical processes in semiconductors.

The rich physics of the optical properties of semiconductors, as well as the advanced processing available on these materials, enabled numerous applications (lasers, LEDs and solar cells) as well as the realization of new physical concepts. Systems that will be covered include quantum dots, exciton-polaritons, quantum Hall fluids and graphene-like materials.

Objective

Electronic states in III-V materials and quantum structures, optical transitions, excitons and polaritons, novel two dimensional semiconductors, spin-orbit interaction and magneto-optics.

Prerequisites / notice

Prerequisites: Quantum Mechanics I, Introduction to Solid State Physics

Abstract

Ultrashort pulse generation, few-cycle pulses, frequency combs, ultrafast measurement techniques.

Objective

This lecture will introduce students to active ongoing research topics and provide their fundamental background.
Terahertz Technology and Applications

This course gives a practical overview over the generation of THz frequency electromagnetic radiation and over the applications of this radiation in a variety of fields, both scientific and industrial.

Terahertz frequency electromagnetic radiation lies at the border between electronics and optics, and as such has many unique properties that make it well-suited to study the electronic, magnetic and structural properties of many materials. The course objective is to give students the ability to identify problems that can be addressed using terahertz frequency radiation and to design (on a conceptual level) a way to implement solutions to these problems. These problems include both scientific (in physics, chemistry and biology) and industrial (medicine, pharmaceuticals, security) areas.

On the scientific side the applications of THz relate to understanding the electronic, structural and magnetic properties of materials by studying the optical response at low frequencies without the need for physical contact with the sample. The industrial applications tend to be more related imaging (e.g. THz-based airport scanners), but also some spectroscopy is done to identify materials.

Topics to be discussed in the class include:

1) Overview of THz & interactions with matter
2) THz generation methods
3) THz optics and electronics
4) THz detection methods
5) THz applications
   - a) Spectroscopy
   - b) Imaging

Although many lectures will follow the course texts, significant deviations will be distributed as a script.

The readings for the course will be selected from several different texts. All of these are available electronically via the ETH library system. You can also order a black-and-white paperback via an "on-demand" system for a pretty reasonable price.

Prerequisites / notice


Quantum electronics.
First semester (Astro-Particle Physics I):
Here is the rough plan of the topics, however the actual pace may vary relative to this plan.

Golub, Richardson & Lamoreaux: "Ultra-Cold Neutrons"

Low Energy Particle Physics
Theoretical basis and selected experiments to determine the properties of neutrinos and their interactions (mass, spin, helicity, chirality, - 'cosmic accelerators')

This is the first of two courses, introducing particle accelerators from a theoretical point of view and covers state-of-the-art modeling techniques. It emphasizes the multidisciplinary aspect of the field, both in methodology (numerical and computational methods) and with regard to applications such as medical, industrial, material research and particle physics.

Besides the sensitivity to effects related with new physical phenomena (e.g. lepton flavor violation, symmetry violations, CPT tests, search for electric dipole moments, new low mass exchange bosons etc.), low energy physics provides the best test of QED (electron g-2), the best tests of bound-state QED (atomic physics and exotic atoms), precise determinations of fundamental constants, information about the CKM matrix, precise information on the weak and strong force even in the non-perturbative regime etc.

In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Starting from a general introduction on high intensity/high precision particle physics and the main characteristics of muons and neutrons and their production, we will then focus on the discussion of fundamental problems and groundbreaking experiments:

- Production and characteristics of muon and neutron beams
- Ultracold neutron production
- Measurement of the neutron lifetime and electric dipole moment
- The neutron in the gravitational field and its electric charge
- Muon and neutron decay correlations
- Lepton flavour violations with muons to search for new physics
- What atomic physics can do for particle physics and vice versa
- Laser experiments at accelerators
- From myonic hydrogen to the proton structure and bound-state QED
- From pionic hydrogen to the strong interaction and effective field theories
- etc.

Literature
Goebel, Richardson & Lamoreaux: "Ultra-Cold Neutrons"
Rauch & Werner: "Neutron Interferometry"
Carille & Wills: "Experimental Neutron Scattering"
Byrne: "Neutrons, Nuclei and Matter"
Klapdor-Kleingrothaus: "Non Accelerator Particle Physics"

Objective
The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons.

Content
Low energy particle physics provides complementary information to high energy physics with colliders. At the Large Hadron Collider one directly searches for new particles at energies up to the TeV range. In a complementary way, low energy particle physics indirectly probes the existence of such particles and provides constraints for "new physics", making use of precision and high intensities.

Besides the sensitivity to effects related with new physical phenomena (e.g. lepton flavor violation, symmetry violations, CPT tests, search for electric dipole moments, new low mass exchange bosons etc.), low energy physics provides the best test of QED (electron g-2), the best tests of bound-state QED (atomic physics and exotic atoms), precise determinations of fundamental constants, information about the CKM matrix, precise information on the weak and strong force even in the non-perturbative regime etc.

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- From pionic hydrogen to the strong interaction and effective field theories
- etc.

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Carille & Wills: "Experimental Neutron Scattering"
Byrne: "Neutrons, Nuclei and Matter"
Klapdor-Kleingrothaus: "Non Accelerator Particle Physics"
QCD: Theory and Experiment

Abstract
An introduction to the theoretical aspects and experimental tests of QCD, with emphasis on perturbative QCD and related experiments at colliders.

Objective
Knowledge acquired on basics of perturbative QCD, both of theoretical and experimental nature. Ability to perform simple calculations of perturbative QCD, as well as to understand modern publications on theoretical and experimental aspects of perturbative QCD.

Content
- QCD Lagrangian and Feynman Rules
- QCD running coupling
- Parton model
- Altarelli-Parisi equations
- Basic processes
- Experimental tests at lepton and hadron colliders
- Measurements of the strong coupling constant

Literature
2) R. K. Ellis, W. J. Stirling, B. R. Webber: "QCD and Collider Physics" (Cambridge Monographs on Particle Physics, Nuclear Physics & Cosmology)"

Energy and Environment in the 21st Century (Part I)

Abstract
The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

Objective
Scientists and especially physicists are often confronted with questions related to the problems of energy and the environment.

The lecture tries to address the physical principles of today's and tomorrow's energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energy problem of the 21st century.

Content
- Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human need/use?
- Energy conservation and the first and second law of thermodynamics
- Fossil fuels (our stored energy resources) and their use.
- Burning fossil fuels and the physics of the greenhouse effect.
- Physics basics of nuclear fission and fusion energy
- Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.
- Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.
- The problems with nuclear fusion and the ITER project.
- Nuclear fusion and fission: "exotic" ideas.
- Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.
- New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)
- Energy perspectives for the next 100 years and some final remarks

Lecture notes
many more details (in English and German) here:
http://ihp-lx2.ethz.ch/energy21/

Literature
Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice
Will be given as block course, language: English.
For students of both ETH and University of Zurich.
The course gives an introduction to symmetry groups in physics. It will explain the relevant mathematical background (finite groups, Lie groups and algebras as well as their representations), and illustrate their important role in modern physics.

Objective

The aim of the course is to give a self-contained introduction into finite group theory as well as Lie theory from a physicists point of view. Abstract mathematical constructions will be illustrated with examples from physics.

The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

Objective

With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

Content

- Theory part:
  - the Standard Model and the mass problem: WW scattering and the no-lose theorem
  - the Higgs mechanism and its implementation in the Standard Model
  - theoretical constraints on the Higgs mass; the hierarchy problem
  - Higgs production in e+e- collisions
  - Higgs production at hadron colliders
  - Higgs decays to fermions and vector bosons
  - Higgs differential distributions, rapidity distribution, pt spectrum and jet vetoes
  - Higgs properties and beyond the Standard Model perspective

- Outlook: The Higgs sector in weakly coupled and strongly coupled new physics scenarios.

Experimental part:

- * Introductory material:
  - reminders of detectors/accelerators
  - reminders of statistics: likelihoods, hypothesis testing
  - reminders of multivariate techniques: Neural Networks, Decision Trees
  - * Main topics:
    - pre-history (pre-LEP)
    - LEP1: measurements at the Z-pole
    - LEP2: towards the limit mH<114 GeV
    - TeVatron searches
    - LHC:
      - main channels overview
      - disect on analysis
      - combine information from all channels
      - differential measurements
      - off-shell measurements
      - Future:
        - pseudo-observables / EFT
        - Beyond Standard Model

Literature

- Higgs Hunter's Guide
  - by S.Dawson, J. Gunion, H. Haber and G. Kane

Prerequisites / notice

Prerequisites: Quantum Field Theory I, Phenomenology of Particle Physics I

This course offers an introduction to quantum field theories, in particular QCD, formulated on a space-time lattice. The lattice provides a non-perturbative, gauge-invariant regularization scheme for the Euclidean path integral. The course introduces both the theoretical background and the computational tools, like Monte Carlo simulations, used for the quantitative study of quarks and gluons.

Objective

To gain familiarity with the formalism of lattice field theories and their numerical simulation methods.

The goal of this course is to introduce the foundations of quantum information theory. It starts with a brief introduction to the mathematical theory of information and then discusses the basic information-theoretic aspects of quantum mechanics. Further topics include applications such as quantum cryptography and quantum computing.

Objective

The course gives an insight into the notion of information and its relevance to physics and, in particular, quantum mechanics. It also serves as a preparation for further courses in the area of quantum information sciences.

This course covers elasticity, dislocation-mediated melting of 2d crystals, Roughening transition, Liquid crystals (classification, elasticity, defects...), Polymers (single chain, Flory scaling, dynamics...), Membranes...

Abstract

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      - main channels overview
      - disect on analysis
      - combine information from all channels
      - differential measurements
      - off-shell measurements
      - Future:
        - pseudo-observables / EFT
        - Beyond Standard Model

Literature

- Higgs Hunter's Guide
  - by S.Dawson, J. Gunion, H. Haber and G. Kane

Prerequisites / notice

Prerequisites: Quantum Field Theory I, Phenomenology of Particle Physics I

This course offers an introduction to quantum field theories, in particular QCD, formulated on a space-time lattice. The lattice provides a non-perturbative, gauge-invariant regularization scheme for the Euclidean path integral. The course introduces both the theoretical background and the computational tools, like Monte Carlo simulations, used for the quantitative study of quarks and gluons.

Objective

To gain familiarity with the formalism of lattice field theories and their numerical simulation methods.

The goal of this course is to introduce the foundations of quantum information theory. It starts with a brief introduction to the mathematical theory of information and then discusses the basic information-theoretic aspects of quantum mechanics. Further topics include applications such as quantum cryptography and quantum computing.

Objective

The course gives an insight into the notion of information and its relevance to physics and, in particular, quantum mechanics. It also serves as a preparation for further courses in the area of quantum information sciences.

This course covers elasticity, dislocation-mediated melting of 2d crystals, Roughening transition, Liquid crystals (classification, elasticity, defects...), Polymers (single chain, Flory scaling, dynamics...), Membranes...

Abstract

The course gives an introduction to symmetry groups in physics. It will explain the relevant mathematical background (finite groups, Lie groups and algebras as well as their representations), and illustrate their important role in modern physics.

Objective

The aim of the course is to give a self-contained introduction into finite group theory as well as Lie theory from a physicists point of view. Abstract mathematical constructions will be illustrated with examples from physics.
The course begins with some mathematical background like fibre bundles. It covers the quantum Hall effect from various perspectives (phenomenology, heuristic explanation, role of disorder, Landau Hamiltonian, Kubo formula, Chern numbers, index of a pair of projections, bulk and edge). Also discussed: Topological insulators and their indices; the Kitaev table. If time permits, quantum pumps.

**Content**

The course begins with some mathematical background like fibre bundles, connections, holonomy and curvature. It covers the quantum Hall effect from various perspectives (phenomenology, heuristic explanation, role of disorder, Landau Hamiltonian, Kubo formula, Chern numbers, index of a pair of projections, bulk and edge). Also discussed in a similar vein: Topological insulators and their indices; the Kitaev table. If time permits, quantum pumps.

**2V+2U**

**402-0873-65L**

**Title**

Partial Differential Equations of Quantum Physics

**Type**

W

**ECTS**

4 credits

**Prerequisites / notice**

I. M. Sigal

In this course we cover several fundamental equations of quantum physics: the Schrödinger equation, which lies at the foundation of Quantum Mechanics, the Gross-Pitaevskii, Landau-Lifshitz and Hartree and Hartree-Fock equations playing an important role in condensed matter physics, the Ginzburg-Landau equations of superconductivity, and the Yang-Mills equations of particle physics.

**2V+1U**

**402-0811-00L**

**Title**

Programming Techniques for Scientific Simulations I

**Type**

W

**ECTS**

5 credits

**Prerequisites / notice**

4G

M. Troyer

This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained.

**2V**

**402-0809-00L**

**Title**

Introduction to Computational Physics

**Type**

W

**ECTS**

8 credits

**Prerequisites / notice**

2V+2U

H. J. Herrmann

This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions

**W**

**402-0877-40L**

**Title**

Statistical Methods in Cosmology and Astrophysics

**Type**

W

**ECTS**

3 credits

**Prerequisites / notice**

2V+1U

I. M. Sigal

Statistical methods play a vital role in modern cosmology and astrophysics studies. This course will give an overview of the statistical principles and tools that are used in these fields. Topics covered will include basic probability theory, Bayesian inference, hypothesis testing, sampling and estimators.

**W**

**402-0867-00L**

**Title**

Programming Techniques for Scientific Simulations II

**Type**

W

**ECTS**

6 credits

**Prerequisites / notice**

3G

M. Troyer

This course covers advanced general and C++ programming techniques relevant for scientific simulations. The course will cover, in particular:

- generic algorithm and library design
- exception safety
- smart pointers and safe memory handling
- polymorphism at compile time, at run time and hybrid designs
- mixed language programs, in particular C++, C, Fortran and Python, and the Boost.Library
- template meta programming and relevant libraries
- C++ libraries for parallel programming on distributed and shared memory machines
- Useful C++ libraries from Boost and other sources

**W**

**402-0580-00L**

**Title**

Superconductivity

**Type**

W

**ECTS**

6 credits

**Prerequisites / notice**

2V+1U

R. Chitra

Topics: occurrence of superconductivity, basic phenomena, thermodynamics, electrodynamics, London equation, Pippard theory, Ginzburg-Landau theory and -equations, flux quantization, magnetic properties of type I and II superconductors, BCS theory, tunnel effects with superconductors, Josephson effects, superconducting quantum interference devices (SQUID), introduction to high-Tc superconductivity.

**W**

**402-0375-64L**

**Title**

Statistical Methods in Cosmology and Astrophysics

**Type**

W

**ECTS**

6 credits

**Prerequisites / notice**

2V+1U

A. Amara

Statistical methods play a vital role in modern cosmology and astrophysics studies. This course will give an overview of the statistical principles and tools that are used in these fields. Topics covered will include basic probability theory, Bayesian inference, hypothesis testing, sampling and estimators.

**W**

**402-0381-64L**

**Title**

Hot Topics in Astrophysics

**Type**

W

**ECTS**

4 credits

**Prerequisites / notice**

2V

M. Carollo

The theme we want to discuss this year is: what do we know about the assembly of diffuse baryons into galaxies and stars, from the physics that govern the birth of new stars, out to the dark matter halos onto which baryons are accreted on cosmological timescales. Specifically, we will focus on the following two -- or, time-permitting, three -- Hot Topics in Astrophysics.

**W**

**402-0353-63L**

**Title**

Observational Techniques in Astrophysics

**Type**

W

**ECTS**

6 credits

**Prerequisites / notice**

2V+1U

K. Schawinski

The course introduces analysis techniques, the basics of astronomical instruments, real-world observational tools, data reduction strategy and software packages used in astrophysics research. The course will also include discussions of current topics in astrophysics with a focus on active galaxies. The course will include the reduction and analysis of real data from a variety of observatories.

**W**

**Data:** 06.12.2018 13:04

**Autumn Semester 2015**

**Page:** 1157 of 1432
The course provides an introduction to fundamental processes characterising astrophysical plasmas, including the theory of waves in collisionless plasmas, plasma instabilities, Landau damping and Cherenkov emission, nonlinear wave-wave and particle-wave interactions.

Objective

Content

become familiar with fundamental plasma processes relevant for dilute astrophysical plasmas

basic concepts (Debye shielding, magnetisation, collisions), particle trajectories (drifts, guiding centers, adiabatic invariants, magnetic mirrors), collisions (angular deflections, energy and momentum losses, timescales), theory of waves in cold and warm collisionless plasmas (dielectric function, dispersion relation, longitudinal and transverse waves, cutoff, resonance, Landau damping); plasma instabilities (two-stream, Weibel, bump-in-tail, ion-acoustic), nonlinear wave-wave and particle wave interactions.

Literature

Lecture notes; Plasma Physics for Astrophysics (R. Kulsrud); Plasma Astrophysics (A. Benz); Basic Principles of Plasma Physics (S. Ichimaru); Kinetic Physics (Landau and Lifshitz, Course of Theoretical Physics 10)

402-0379-65L

Kinetic Plasma Processes in Astrophysics

W 6 credits 2V+1U F. Miniati

Most of the visible matter in the universe is in a plasma state, i.e. a gas of charged particles. This course provides an introduction to various aspects of plasma physics, including the behavior of plasmas in different environments, such as the solar wind and energetic plasma.

Objective

Abstract

This course will take place with a minimum of 4 participants.

551-1601-00L

Biophysics of Biological Macromolecules

W 6 credits 2V+1U G. Wider, F. Allain, A. Cléry

The course will only take place with a minimum of 4 participants.
This lecture course targets physics students and students of interdisciplinary sciences (major physics) for their education in biology. In this course the basics of molecular biology are presented bearing in mind the special interests of the physics students.

**Objective**
Basics of molecular biology and biophysics in in view of the special interest of students in physics.

**Content**
This lecture course targets physics students and students of interdisciplinary sciences (major physics) for their education in biology. In this course the basics of molecular biology are presented bearing in mind the special interests of the physics students. The topics include: properties of biological macromolecules, introduction to the genetic system of E. coli bacteria, transcription, translation, discussion of structure and function of proteins, quantitative description of enzyme function and allosteric interactions, biotechnology, introduction to optical spectroscopy, X-ray crystallography and nuclear magnetic resonance (NMR) spectroscopy of biopolymers in solution.

**Lecture notes**
- additional documentation in support of text book

**Selection: Medical Physics**

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>402-0341-00L</td>
<td>Medical Physics I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>P. Manser</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

**Objective**
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learning how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

**Content**
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

**Lecture notes**
A script will be provided.

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<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>B. K. R. Müller</td>
</tr>
</tbody>
</table>

**Abstract**
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

**Objective**
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocot cell behavior.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced. The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering. Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue’s anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

**Selection: Environmental Physics**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0572-00L</td>
<td>Aerosols I: Physical and Chemical Principles</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>M. Gysel, U. Baltensperger, H. Bartscher</td>
</tr>
</tbody>
</table>

**Abstract**
Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.

**Objective**
Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields is discussed.

**Content**
physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, absorption, extinction), aerosol production, physical and chemical characterization.

**Lecture notes**
materiel is distributed during the lecture.
**Selection: Mathematics**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3591-65L</td>
<td>Introduction to Random Graphs</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>A. Knowles</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is an introductory course on random graphs, covering Erdos-Renyi graphs, inhomogeneous graphs, phase transition phenomena, connectivity, and random walks on random graphs.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>A basic undergraduate course on probability.</td>
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<tr>
<td>401-4785-65L</td>
<td>Partial Differential Equations</td>
<td>W</td>
<td>7</td>
<td>4V</td>
<td>D. Christodoulou</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers elliptic partial differential equations in connection to differential geometry and geometric elliptic variational problems. The main topics are the uniformization theorem for 2-dim Riemannian manifolds, harmonic maps from the unit disc to a n-dim Riemannian manifold, and the theory of parametric minimal surfaces in n-dim Euclidean space.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Real Analysis and Differential Geometry</td>
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<tr>
<td>401-3531-00L</td>
<td>Differential Geometry I</td>
<td>W</td>
<td>10</td>
<td>4V+1U</td>
<td>M. Burger</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is an introduction to differential and riemannian geometry. The aim is to lead students from a reasonable knowledge of advanced calculus, basic knowledge of general topology and solid knowledge of linear algebra to fundamental knowledge of differentiable manifolds and their basic tools. Riemannian geometry, some basic Lie theory, and de Rham cohomology will be developed as applications.</td>
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<tr>
<td>Objective</td>
<td>Literature</td>
<td>W. Boothby <em>An introduction to differentiable manifolds and Riemannian geometry</em></td>
<td></td>
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<tr>
<td>Literature</td>
<td>W. Boothby <em>An introduction to differentiable manifolds and Riemannian geometry</em></td>
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<tr>
<td>401-3601-00L</td>
<td>Functional Analysis I</td>
<td>W</td>
<td>10</td>
<td>4V+1U</td>
<td>D. A. Salamon</td>
</tr>
<tr>
<td>Abstract</td>
<td>Baire category; Banach and Hilbert spaces, bounded linear operators; Three Fundamental Principles: Uniform Boundedness, Open Mapping/Closed Graph, Hahn-Banach; Convexity; Dual Spaces: weak and weak* topologies, Banach-Alaoglu, reflexive spaces; Ergodic Theorem; compact operators and Fredholm theory, Closed Image Theorem; Spectral theory, self-adjoint operators.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture Notes on “Functional Analysis” by D.A. Salamon</td>
<td></td>
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</tr>
<tr>
<td>401-3601-00L</td>
<td>Probability Theory</td>
<td>W</td>
<td>10</td>
<td>4V+1U</td>
<td>A.S. Sznitman</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<tr>
<td>Objective</td>
<td>Content</td>
<td>This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<tr>
<td>401-3621-00L</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>W</td>
<td>10</td>
<td>4V+1U</td>
<td>S. van de Geer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers the basics of inferential statistics.</td>
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</tbody>
</table>

**Selection: Electives at the University of Zurich**

University of Zurich lecturers explicitly recommended the following courses also to physics students at ETH Zurich. Recognition of the corresponding external ECTS credits has to be granted by the Head of Studies. Submit your request to the Study Administration Office (www.phys.ethz.ch/phys/education/studiensekretariat/?lang=en).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-7851-00L</td>
<td>Theoretical Astrophysics (University of Zurich)</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>R. Teyssier</td>
</tr>
<tr>
<td>Abstract</td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: ASTS12 Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<tr>
<td>Literature</td>
<td>Radiative processes in the interstellar medium; stellar structure and evolution; supernovae: white dwarfs; neutron stars; black holes; planet formation</td>
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<td>(1) &quot;Formation of stars&quot; (S. Stahler and F. Palla - Wiley editions, this is the book on which about half of the classes will be based and photocopies will be organized during first lecture)</td>
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<tr>
<td></td>
<td>(2) &quot;Radiative processes in astrophysics&quot; (R. Rybicky and A. Lightman)</td>
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<td>(3) &quot;The Physics of Stars&quot; (A.C. Phillips)</td>
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<td></td>
<td>(4) &quot;Black Holes, White Dwarfs and Neutron Stars: The physics of compact objects&quot; (S. Shapiro and S.A. Teukolsky). Additionally PowerPoint slides will be prepared by the lecturer on these and extra topics (e.g. planet formation).</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Elementary atomic physics, thermodynamics, mechanics, fluid dynamics. Introduction to astrophysics (preferred but not obligatory).</td>
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</table>

| 401-7855-00L    | Computational Astrophysics (University of Zurich) | W    | 6      | 2V    | L. M. Mayer        |
Objective
Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes.

Content
1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility
2. Large-N gravity calculation, collisionless N-body systems and their simulation
3. Fast Fourier Transform and spectral methods in general
4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters
5. Lagrangian Hydrodynamics; The SPH method
6. Resolution and instabilities in Hydrodynamics
7. Initial Conditions: Cosmological Simulations and Astrophysical Disks
8. Physical Approximations and Methods for Radiative Transfer in Astrophysics

Literature
Galactic Dynamics (Binney & Tremaine, Princeton University Press),
Computer Simulation using Particles (Hockney & Eastwood CRC press),
Targeted journal reviews on computational methods for astrophysical fluids (SPH, AMR, moving mesh)

Prerequisites / notice
Some knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python/ as an example), some prior experience programming, knowledge of C, C++ beneficial

General Electives

Students may choose General Electives from the entire course programme of ETH Zurich - with the following restrictions: courses that belong to the first or second year of a Bachelor curriculum at ETH Zurich as well as courses from the Compulsory Electives in Humanities, Social and Political Sciences are not eligible here.

The following courses are explicitly recommended to physics students by their lecturers. (Courses in this list may be assigned to the category “General Electives” directly in myStudies. For the category assignment of other eligible courses keep the choice “no category” and take contact with the Study Administration Office (www.phys.ethz.ch/phys/education/studiensekretariat/?lang=en) after having received the credits.)

Number Title Type ECTS Hours Lecturers
529-0433-00L Advanced Physical Chemistry: Statistical Thermodynamics W 7 credits 3G G. Jeschke

Abstract
Introduction to statistical mechanics and thermodynamics. Prediction of thermodynamic and kinetic properties from molecular data.

Objective
Introduction to statistical mechanics and thermodynamics. Prediction of thermodynamic and kinetic properties from molecular data.

Content

Lecture notes
See homepage of the lecture.

Literature
Chemical Thermodynamics, Reaction Kinetics, Molecular Quantum Mechanics and Spectroscopy; Mathematical Foundations (Analysis, Combinatorial Relations, Integral and Differential Calculus)

151-0163-00L Nuclear Energy Conversion W 4 credits 2V+1U H.M. Prasser

Abstract
Physical fundamentals of the fission reaction and the sustainable chain reaction, thermal design, construction, function and operation of nuclear reactors and power plants, light water reactors and other reactor types, conversion and breeding.

Objective
Students get an overview on energy conversion in nuclear power plants, on construction and function of the most important types of nuclear reactors with special emphasis to light water reactors. They obtain the mathematical/physical basis for quantitative assessments concerning most relevant aspects of design, dynamic behaviour as well as material and energy flows.

Content
Nuclear physics of fission and chain reaction. Thermodynamics of nuclear reactors. Design of the reactor core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, difference between thermal reactors and fast breeders. Construction and operation of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion. Development tendencies of reactor technology.

Lecture notes
Hand-outs will be distributed. Additional literature and information on the website of the lab: https://www.ethz.ch/content/specialinterest/mavt/energy-technology/lab-of-nuclear-energy-systems/en/studium/teaching-materials/151-0163-00l-nuclear-energy-conversion.html

Literature
Dieter Smidt: Reaktortechnik, Band 1 und Band 2, G. Braun Karlsruhe, 1971

151-0103-00L Fluid Dynamics II W 3 credits 2V+1U P. Jenny

Abstract

Objective
Expand basic knowledge of fluid dynamics. Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Content

Lecture notes
Lecture notes are available (in German). (See also info on literature below.)

Literature

Prerequisites / notice
Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

151-0213-00L Fluid Dynamics with the Lattice Boltzmann Method W 4 credits 3G I. Karlin

Abstract
The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.

Number Title Type ECTS Hours Lecturers
151-0103-00L Fluid Dynamics II W 3 credits 2V+1U P. Jenny

Abstract

Objective
Expand basic knowledge of fluid dynamics. Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Content

Lecture notes
Lecture notes are available (in German). (See also info on literature below.)

Literature

Prerequisites / notice
Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

151-0213-00L Fluid Dynamics with the Lattice Boltzmann Method W 4 credits 3G I. Karlin

Abstract
The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.
Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   - Particle's distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation;
   - Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   - Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   - Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   - Lattice Boltzmann simulations of turbulent flows;
   - numerical stability and accuracy.

5. Microflow:
   - Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   - Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   - Relativistic fluid dynamics; flows with phase transitions.

Lecture notes

Lecture notes on the theoretical parts of the course will be made available.
Selected original and review papers are provided for some of the lectures on advanced topics.
Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

Prerequisites / notice

The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Code</th>
<th>Instructor</th>
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</thead>
<tbody>
<tr>
<td>151-0105-00L</td>
<td>Quantitative Flow Visualization</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
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<td>T. Rösgen</td>
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Objective
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Content
- Development of basic programming skills for (generic) imaging applications.
- Fundamentals of optics, flow visualization and electronic image acquisition.
- Frequently used mage processing techniques (filtering, correlation processing, FFTs, color space transforms).
- Image Velocimetry (tracking, pattern matching, Doppler imaging).
- Surface pressure and temperature measurements (fluorescent paints, liquid crystal imaging, infrared thermography).
- Laser induced fluorescence.
- (Digital) Schlieren techniques, phase contrast imaging, interferometry, phase unwrapping.
- Wall shear and heat transfer measurements.
- Pattern recognition and feature extraction, proper orthogonal decomposition.

Lecture notes available

Prerequisites / notice
- Prerequisites: Fluid dynamics I, Numerical Mathematics, programming skills.
- Language: German on request.

<table>
<thead>
<tr>
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<th>Credits</th>
<th>Code</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0911-00L</td>
<td>Introduction to Plasmonics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
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<tr>
<td>D. J. Norris</td>
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</table>

Objective
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

Content
- Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.
Content

Fundamentals of Plasmonics
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

Lecture notes
Class notes and handouts

Literature

Prerequisites / notice
Physics I, Physics II

151-0107-20L High Performance Computing for Science and Engineering (HPCSE) I

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

151-0621-00L Microsystems Technology

Abstract
Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and -devices by a sequence of defined processing steps (process flow).

Objective
Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystem devices by the combination of unit process steps (= process flow).

Content
- Introduction to Microsystems Technology (MST) and micro electro mechanical systems (MEMS)
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Specific Microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.

Lecture notes
Handouts (available online)

Literature
- S. M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O. Paul: Microsystems Technology
- G. Kovacs: Micromachined Transducer Sourcebook

Prerequisites / notice
Prerequisites: Physics I and II

227-0385-10L Biomedical Imaging

New course. Not to be confused with 227-0385-00L of fall 2014.

Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.
A. Schenk

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Objective


Lecture notes

Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

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227-0965-00L

Micro and Nano-Tomography of Biological Tissues

Objective

The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

Content

The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions.

The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

Lecture notes

The script (in book style) can be downloaded from: http://www.iis.ee.ethz.ch/schenk/vorlesung

Literature

Will be indicated during the lecture.

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227-0147-00L

VLSI II: Design of Very Large Scale Integration Circuits

Abstract

This second course in our VLSI series is concerned with how to turn digital netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects (clock skew, metastability, ground bounce, IR-drop, electromigration, ESD, latchup). Economic aspects and management issues of VLSI projects are also addressed.

Objective

Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.
### Content
The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:
- Limitations of functional design verification, design for test.
- Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.
- Synchronization and metastability.
- CMOS transistor-level circuits of gates, flip-flops and random access memories.
- Sinks of energy in CMOS circuits.
- Power estimation and low-power design.
- Current research in low-energy computing.
- Layout parasitics, interconnect delay, static timing analysis.
- Switching currents, ground bounce, IR-drop, power distribution.
- Floorplanning, chip assembly, packaging.
- Layout design at the mask level, physical design verification.
- Electromigration, electrostatic discharge, and latch-up.
- Models of industrial cooperation in microelectronics.
- The caveats of virtual components.
- The cost structures of ASIC development and manufacturing.
- Market requirements, decision criteria, and case studies.
- Yield models.
- Avenues to low-volume fabrication.
- Marketing aspects and case studies.
- Management of VLSI projects.

Exercises are concerned with back-end design (floorplanning, placement, routing, clock and power distribution, layout verification). Industrial CAD tools are being used.

### Lecture notes
English lecture notes.

### Literature


### Prerequisites / notice
Highlight:
Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:
"VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs" or equivalent knowledge.

Further details:
http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

### 227-0663-00L Nano-Optics

| Objective | Understanding concepts of light localization and light-matter interactions on the nanoscale. |
| Content   | Starting with an angular spectrum representation of optical fields the role of inhomogeneous evanescent fields is discussed. Among the topics are: theory of strongly focused light, point spread functions, resolution criteria, confocal microscopy, and near-field optical microscopy. Further topics are: optical interactions between nanoparticles, atomic decay rates in inhomogeneous environments, single molecule spectroscopy, light forces and optical trapping, photonic bandgap materials, and theoretical methods in nano-optics. |
| Prerequisites / notice | - Electrodynamics (or equivalent)  
- Physics I+II |

### 227-0655-00L Nonlinear Optics

| Takes place in spring 2016 |
| Objective | The important nonlinear optical phenomena are understood and can be classified. The effects can be described mathematical by means of the susceptibility. |
| Content   | Chapter 1: The Wave Equations in Nonlinear Optics  
Chapter 2: Nonlinear Effects - An Overview  
Chapter 3: The Nonlinear Optical Susceptibility  
Chapter 4: Second Harmonic Generation  
Chapter 5: The Electro-Optic Effect and the Electro-Optic Modulator  
Chapter 6: Acousto-Optic Effect  
Chapter 7: Nonlinear Effects of Third Order  
Chapter 8: Nonlinear Effects in Media with Gain |

### 227-0301-00L Optical Communication Fundamentals

| The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system. This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements. |
| Objective | An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications. |
A document containing theory, background and practical course content is distributed at the first meeting of the course. The document provides sufficient information for the participants to successfully participate in the course. The course is for advanced students and covers selected topics from magnetic resonance spectroscopy. This year, the lecture will be given by H. Gross. Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

Priorities for students to attend the course:

- Master students of the master's program in "Micro and Nanosystems"
- Master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MADV-tutors Profs. Daraio, Dual, Hierold, Koumoutsakos, Nelson, Norris, Park, Poulakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.
- Bachelor students of the bachelor program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MADV-tutors Profs. Daraio, Dual, Hierold, Koumoutsakos, Nelson, Norris, Park, Poulakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.
- All other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

- Participating students are required to provide proof that they have personal accident insurance prior to the start of the laboratory portion of the course.
- Participating students are required to attend all scheduled lectures and meetings of the course.

The course is offered in autumn and spring semester.

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Literature</th>
<th>Prerequisites / notice</th>
</tr>
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</table>

### 151-0620-00L

**Objective**

Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

**Content**

With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerometer are carried out:

- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

### 529-0443-00L

**Abstract**

The course is for advanced students and covers selected topics from magnetic resonance spectroscopy. This year, the lecture will introduce and discuss the theoretical foundation of high-resolution solid-state NMR under magic-angle spinning.

**Objective**

The aim of the course is to familiarize the students with the basic concepts of high-resolution solid-state NMR. Starting from the mathematical description of spin dynamics, important building blocks for multi-dimensional experiments are discussed to allow students a better understanding of modern solid-state NMR experiments.

**Content**

The basic principles of NMR in solids will be introduced. After the discussion of basic tools to describe NMR experiments, basic methods and experiments will be discussed, e.g., magic-angle spinning, cross polarization, decoupling, and recoupling experiments. Such basic building blocks allow a tailoring of the effective Hamiltonian to the needs of the experiment. These basic building blocks can then be combined in different ways to obtain spectra that contain the desired information.

**Lecture notes**

A script which covers the topics will be distributed in the lecture and will be accessible through the web page [http://www.ssnmr.ethz.ch/education/](http://www.ssnmr.ethz.ch/education/)

### 327-0703-00L

**Abstract**

A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

**Objective**

A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

**Content**

This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in material science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

**Lecture notes**

English
The project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data. A successful participant of the course is able to:

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

The course is structured along three main tasks:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

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

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

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

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

Proséminars and Semester Papers

To organise a semester project take contact with one of the instructors.

Not all lecturers are directly eligible in myStudies if "Professors" is the required type of lecturers. In such cases please take contact with the Study Administration Office (http://www.phys.ethz.ch/phys/education/studiensekretariat/?lang=en).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0210-95L</td>
<td>Proseminar Theoretical Physics: Particle Physics at the Energy Frontier</td>
<td>W</td>
<td>9 credits</td>
<td>4S</td>
<td>A. Lazopoulos</td>
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<td>Number of participants limited to 24.</td>
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<tr>
<td></td>
<td>A guided self-study of original papers and of advanced textbooks in theoretical physics. Within the general topic, determined each semester, participants give a presentation on a particular subject and deliver a written report.</td>
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<td>This course unit is an alternative if no suitable &quot;Proseminar Theoretical Physics&quot; is available if the proseminar is already overbooked.</td>
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<td>Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein.</td>
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<tr>
<td>402-0215-ML</td>
<td>Experimental Semester Project in a Group of the Physics Department</td>
<td>W</td>
<td>9 credits</td>
<td>18A</td>
<td>Professors</td>
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<td>The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.</td>
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<tr>
<td>402-0510-ML</td>
<td>Advanced Solid State Physics Experiments</td>
<td>W</td>
<td>9 credits</td>
<td>18B</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>
Supervisors for this experimental semester paper:
Prof. Bertram Batlogg
Prof. Christian Degen
Prof. Leonardo Degiorgi
Prof. Klaus Ensslin
Prof. Thomas Ihn
Prof. Joël Mesot
Prof. Andreas Valerlaus
Prof. Andreas Wallraff
Prof. Werner Wegscheider
Prof. Andrey Zheludev

Abstract
Experiments in condensed matter physics. The work includes the planning, build-up, data taking and analysis, and interpretation of the experimental results.

Objectives

Content

Lecture notes
n/a

Prerequisites / notice
Arbeiten in einer Forschungsgruppe sind besonders gut geeignet, die Studierenden mit aktuellen Forschungsthemen und mit moderner Instrumentierung bekannt zu machen.

402-0400-MSL Advanced Quantum Electronics Experiments

Abstract
Implementation of experiments in quantum electronics. Planning, design, realisation, evaluation, and interpretation of the experiments.

Content

402-0717-MSL Particle Physics at CERN

Abstract
During the semester break participating students stay for 4 weeks at CERN and perform experimental work relevant to our particle physics projects. Dates to be agreed upon.

Objective
Students learn, by doing, the needed skills to perform a small particle physics experiment: setup, problem solving, data taking, analysis, interpretation and presentation in a written report of publication quality.

Content
Detailed information in: http://www@cmsdoc.cern.ch/~nessif/ETHTeilchenpraktikumCERN.html

Language of instruction: English or German

402-0719-MSL Particle Physics at PSI (Paul Scherrer Institute)

Abstract
During semester breaks 6-12 students stay for 3 weeks at PSI and participate in a hands-on course on experimental particle physics. A small real experiment is performed in common, including apparatus design, construction, running and data analysis. The course includes some lectures, but the focus lies on the practical aspects of experimenting.

Objective
Students learn all the different steps it takes to perform a complete particle physics experiment in a small team. They acquire skills to do this themselves in the team, including design, construction, data taking and data analysis.

402-0340-MSL Medical Physics

Abstract
In agreement with the lecturers a semester paper in the context of the topics discussed in the lectures can be written.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-PHYS.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis (Programme Regulations 2007)

Number Title Type ECTS Hours Lecturers
402-2000-00L Scientific Works in Physics O 0 credits D. Würtz

Abstract
Target audience: Master students who cannot document to have received an adequate training in working scientifically. Mandatory for all Master students with matriculation in the autumn semester 2014 or later. Optional for Master students with matriculation until or before the spring semester 2014. Directive

Objective
Literature Review: ETH-Library, Journals in Physics, Google Scholar; Thesis Structure: The IMRAD Model; Document Processing: LaTeX and BibTeX, Mathematical Writing, AVETH Survival Guide; ETH Guidelines for Integrity; Authorship Guidelines; ETH Citation Etiquettes; Declaration of Originality.

402-0900-00L Master's Thesis O 25 credits 46D Professors

Abstract
Only students who fulfil the following criteria are allowed to

begin with their master's thesis:
- successful completion of the bachelor programme;
- fulfilling of any additional requirements necessary to gain admission to the master programme;
- have acquired at least 9 credits in the category Proseminars and Semester Papers.

Please send the completed form https://www.phys.ethz.ch/content/dam/ethz/main/education/bachelor/physik/files/2014-10-Masterarbeit_%20PHYS_Regl%202007.pdf to the Study Administration
Further information: www.phys.ethz.ch/phys/education/master/msc-theses

Abstract
The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

► Master Thesis (Programme Regulations 2014)

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<thead>
<tr>
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<td>Scientific Works in Physics</td>
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<td>D. Würtz</td>
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<td>Target audience:</td>
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<td><a href="http://www.phys.ethz.ch/phys/education/master/msc-theses">http://www.phys.ethz.ch/phys/education/master/msc-theses</a></td>
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Abstract
Literature Review: ETH-Library, Journals in Physics, Google Scholar; Thesis Structure: The IMRAD Model; Document Processing: LaTeX and BibTeX, Mathematical Writing, AVETH Survival Guide; ETH Guidelines for Integrity; Authorship Guidelines; ETH Citation Etiquettes; Declaration of Originality.

Objective
Basic standards for scientific works in physics: How to write a Master Thesis. What to know about research integrity.

402-0900-30L | Master's Thesis                        | O    | 30   | 57D   | Supervisors |
|             | Only students who fulfill the following criteria are allowed to begin with their master's thesis:
|             | a. successful completion of the bachelor programme;
|             | b. fulfilling of any additional requirements necessary to gain admission to the master programme;
|             | c. have acquired at least 8 credits in the category Proseminars and Semester Papers. |
|             | Further information: http://www.phys.ethz.ch/phys/education/master/msc-theses |

Abstract
The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

► Seminars, Colloquia, and Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>402-0247-00L</td>
<td>Electronics for Physicists I (Analogue)</td>
<td>Z</td>
<td>4</td>
<td>2+2P</td>
<td>R. Horisberger</td>
</tr>
<tr>
<td></td>
<td>Content</td>
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</tr>
<tr>
<td></td>
<td>Passive elements, linear complex networks, transmission lines, simulation of analog circuits, semiconductor elements: diodes, bipolar and field effect transistors, basic amplifier circuits, small signal analysis, differential amplifiers, noise in analog circuits, operational amplifiers, OTAs, gyrator circuits, feedback and stability in amplifiers, oscillators, ADCs and DACs, introduction in CMOS technology</td>
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<td></td>
<td>Prerequisites / notice</td>
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</table>


Abstract
Research colloquium
Occasionally, talks may be delivered in German.

402-0800-00L | The Zurich Theoretical Physics Colloquium | E-   | 0    | 1K    | S. Huber, C. Anastasiou, N. Beisert, G. Blatter, M. Gaberdiel, |

Data: 06.12.2018 13:04  Autumn Semester 2015  Page 1169 of 1432
The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.

**Objective**

Discussion of state of the art techniques and methodologies in scientific computing.

**Content**

This course consists of seminars by invited speakers on subjects of interest for the "Platform for Advanced Scientific Computing".

**Lecture notes**

There is no script.

**Literature**

Literature will be provided by the speakers in their respective presentations.

**Prerequisites / notice**

Participants should have experience on advanced scientific computing.

---

**Abstract**

Seminars by invited speakers in the area of advanced scientific computing.

**Objective**

Discussion of state of the art techniques and methodologies in scientific computing.

**Content**

This course consists in a series of seminars by invited speakers on subjects of interest for the "Platform for Advanced Scientific Computing".

**Lecture notes**

There is no script.

**Literature**

Literature will be provided by the speakers in their respective presentations.

**Prerequisites / notice**

Participants should have experience on advanced scientific computing.
Seminar on Biomedical Magnetic Resonance
Objective: Actuel developments and problems of magnetic resonance imaging (MRI)
Abstract: Getting insight to advanced topics in Magnetic Resonance Imaging
227-1043-00L
Neuroinformatics - Colloquia
Objective: The colloquium in Neuroinformatics is a series of lectures given by invited experts. The lecture topics reflect the current themes in neurobiology and neuromorphic engineering that are relevant for our Institute.
Abstract: The goal of these talks is to provide insight into recent research results. The talks are not meant for the general public, but really aimed at specialists in the field.
Content: The topics depend heavily on the invited speakers, and thus change from week to week.

Auditory Informatics
Objective: Invited talks on current research from the following areas: Auditory information processing, auditory sensors (biological and electrical), coding of information, perception, scene-segmentation.
Abstract: Exchange with researchers in the domain of auditory informatics. Preparing and giving a presentation on a suitable topic in front of a scientific audience.
Content: The semester program is available under: http://stoop.ini.uzh.ch/teaching/seminar-on-auditory-informatics
Prerequisites / notice: On request the "Lehrsprache" may be changed to German.

Seminar in Glaciology
Objective: Vertiefte Kenntnisse in ausgewählten Bereichen der glaziologischen Forschung erarbeiten.
Content: Development of a physical understanding for static and dynamic phenomena related to (moving) charged objects and understand the structure of the classical field theory of electrodynamics (transverse versus longitudinal physics, invariances (Lorentz-, gauge-)). Appreciate the interrelation between electric, magnetic, and optical phenomena and the influence of media. Understand a set of classic electrodynamical phenomena and develop the ability to solve simple problems independently. Apply previously learned mathematical concepts (vector analysis, complete systems of functions, Green's functions, co- and contravariant coordinates, etc.). Prepare for quantum mechanics (eigenvalue problems, wave guides and cavities).

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>406-0204-AAL</td>
<td>Electrodynamics</td>
<td>E-</td>
<td>7</td>
<td>15R</td>
<td>C. Anastasiou</td>
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<td>Enrolment only for MSc students who need this course as additional requirement.</td>
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<tr>
<td>Objective</td>
<td>Develop a physical understanding for static and dynamic phenomena related to (moving) charged objects and understand the structure of the classical field theory of electrodynamics (transverse versus longitudinal physics, invariances (Lorentz-, gauge-)). Appreciate the interrelation between electric, magnetic, and optical phenomena and the influence of media. Understand a set of classic electrodynamical phenomena and develop the ability to solve simple problems independently. Apply previously learned mathematical concepts (vector analysis, complete systems of functions, Green's functions, co- and contravariant coordinates, etc.). Prepare for quantum mechanics (eigenvalue problems, wave guides and cavities).</td>
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<tr>
<td>406-0663-AAL</td>
<td>Numerical Methods for CSE</td>
<td>E-</td>
<td>7</td>
<td>15R</td>
<td>R. Hiptmair</td>
</tr>
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</tbody>
</table>
| Abstract   | Introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology.  
* Knowledge of the fundamental algorithms in numerical mathematics  
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms  
* Ability to choose the appropriate numerical method for concrete problems  
* Ability to interpret numerical results  
* Ability to implement numerical algorithms efficiently |      |      |       |                 |
The course will cover the following chapters:

1. Direct Methods for linear systems of equations
2. Interpolation
3. Iterative Methods for non-linear systems of equations
4. Krylov methods for linear systems of equations
5. Eigensolvers
6. Least Squares Techniques
7. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Clustering Techniques
11. Single Step Methods for ODEs
12. Stiff Integrators

Lecture notes
Comprehensive lecture materials are available upon request from the lecturer.

Literature
- M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002
- C. Moler, "Numerical computing with MATLAB", SIAM, 2004

Prerequisites / notice
Solid knowledge about fundamental concepts and techniques from linear algebra & calculus as taught in the first year of science and engineering curricula.

**Physics Master - Key for Type**

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<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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<td>O</td>
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**Key for Hours**

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<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Core Courses

- **Economic Theory for Finance**
  
  For possible additional course offerings see www.msfinance.ch

- **Mathematical Methods for Finance**
  
  For possible additional course offerings see www.msfinance.ch

#### Mathematical Methods for Finance

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3913-01L</td>
<td>Mathematical Foundations for Finance</td>
<td>W</td>
<td>4</td>
<td>3V+2U</td>
<td>E. W. Farkas, M. Schweizer</td>
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**Abstract**
First introduction to main modelling ideas and mathematical tools from mathematical finance

**Objective**
This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

**Content**
Topics to be covered include:
- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô's formula, Girsanov transformation, Itô's representation theorem
- Black–Scholes formula

**Lecture notes**
Lecture notes will be sold at the beginning of the course.

**Literature**
Lecture notes will be sold at the beginning of the course. Additional (background) references are given there.

**Prerequisites / notice**
Prerequisites: Results and facts from probability theory as in the book "Probability Essentials" by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course "Wahrscheinlichkeitstheorie").

For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

### Elective Courses

- **Economic Theory for Finance**
  
  For possible additional course offerings see www.msfinance.ch

#### Data Analytics in Organisations and Business

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-4633-00L</td>
<td>Data Analytics in Organisations and Business</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>I. Flückiger</td>
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</table>

**Abstract**
On the end-to-end process of data analytics in organisations & business and how to transform data into insights for fact based decisions. Presentation of the process from the beginning with framing the business problem to presenting the results and making decisions by the use of data analytics. For each topic case studies from the financial service, healthcare and retail sectors will be presented.

**Objective**
The goal of this course is to give the students the understanding of the data analytics process in the business world, with special focus on the skills and techniques used besides the technical skills. The student will become familiar with the "business language", current problems and thinking in organisations and businesses and tools used.

**Content**
1. Framing the Business Problem
2. Framing the Analytics Problem
3. Data Methodology
4. Model Building
5. Deployment
6. Model Lifecycle
7. Soft Skills for the Statistical/Mathematical Professional

**Lecture notes**
Lecture Notes will be available.

**Prerequisites / notice**
Prerequisites: Basic statistics and probability theory and regression

### Mathematical Methods for Finance

- **Interest Rate Modeling in Discrete Time**
  
  For possible additional course offerings see www.msfinance.ch

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>401-3953-00L</td>
<td>Interest Rate Modeling in Discrete Time</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. V. Wüthrich</td>
</tr>
</tbody>
</table>

**Abstract**
This course gives an introduction to stochastic interest rate modeling in discrete time. Starting from cash flow valuation with state price deflators, we derive the equivalent martingale measures for pricing financial instruments and derivatives of primary assets. The lecture is supplemented by several examples such as the Vasicek model where we also study model calibration.

**Objective**
The students are familiar with the basic terminology of stochastic interest rate modeling and he is able to transfer his (financial) mathematical knowledge to real world pricing of cash flows and financial instruments.

**Content**
The following topics are covered:
1. stochastic discounting with state price deflators
2. equivalent martingale measures
3. pricing of cash flows and primary assets
4. pricing of derivatives, e.g. European put options
5. (multi-factor) Vasicek state price deflator model
6. Heath-Jarrow-Morton interest rate modeling framework

**Lecture notes**
Part I of:
<table>
<thead>
<tr>
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<th>Credits</th>
<th>Type</th>
<th>Tutor</th>
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<tr>
<td>401-4889-00L</td>
<td>Mathematical Finance</td>
<td>12</td>
<td>W</td>
<td>M. Soner</td>
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<tr>
<td>401-4935-63L</td>
<td>Equilibrium Models in Financial Economics</td>
<td>4</td>
<td>W</td>
<td>M. P. G. Herdegen</td>
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<tr>
<td>401-4657-00L</td>
<td>Numerical Analysis of Stochastic Ordinary Differential Equations</td>
<td>6</td>
<td>W</td>
<td>A. Jentzen</td>
</tr>
</tbody>
</table>

**Objective**

1. Understand the conceptual ideas.
2. Learn about the technical tools.
3. Gain an overview over the problems that can be studied and solutions that can be obtained using equilibrium models.

**Content**

- Introduction to equilibrium models:
  1. Understand the conceptual ideas.
  2. Learn about the technical tools.
  3. Gain an overview over the problems that can be studied and solutions that can be obtained using equilibrium models.

**Lecture notes**

None available.

**Prerequisites / notice**

Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

**Literature**

Brownian Motion and Stochastic Calculus, Introduction to Mathematical Finance or Mathematical Foundations for Finance

http://ssrn.com/abstract=2319328

**Notice**

This course will be held in English and counts towards the diploma of "Aktuar SAV". For the latter, see details under www.actuaries.ch.

**Literature**

For further reading:

**Prerequisites / notice**

The exams ONLY take place during the official ETH examination period.

**Prerequisites**:
- knowledge of probability theory
- statistics
- applied stochastic processes.

**Abstract**

- Advanced introduction to mathematical finance:
  - absence of arbitrage and martingale measures
  - option pricing and hedging
  - optimal investment problems
  - additional topics

- Advanced level introduction to mathematical finance, presupposing knowledge in probability theory and stochastic processes

- This is an advanced level introduction to mathematical finance for students with a good background in probability. We want to give an overview of main concepts, questions and approaches, and we do this in both discrete- and continuous-time models. Topics include absence of arbitrage and martingale measures, option pricing and hedging, optimal investment problems, and probably others.

- Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

- This course will be held in English and counts towards the diploma of "Aktuar SAV". For the latter, see details under www.actuaries.ch.

- Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

- The exams ONLY take place during the official ETH examination period.

- Prerequisites: knowledge of probability theory, statistics and applied stochastic processes.
Lecture notes will be available.

P. Glassermann:
Monte Carlo Methods in Financial Engineering.

P. E. Kloeden and E. Platen:
Numerical Solution of Stochastic Differential Equations.

Prerequisites:
Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.

a) mandatory courses:
Elementary Probability, Probability Theory I.

b) recommended courses:
Stochastic Processes.

401-3922-00L Life Insurance Mathematics
W 4 credits 2V M. Koller

Abstract
The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance and disability). Besides that the most important terms such as mathematical reserves are introduced and calculated. The profit and loss account and the balance sheet of a life insurance company is explained and illustrated.

401-4905-60L Interest Rate Theory
W 8 credits 3V+1U not available

Abstract
We introduce and discuss the most important models for interest rate markets. Emphasis will be placed both on theoretical foundations and on numerical implementation and calibration.

Objective
- Gain overview of interest rate markets and the corresponding financial products.
- Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
- Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.
- Learn about extensions that have recently become increasingly important: default risk, multiple yield curves, etc.
- Gain overview of interest rate markets and the corresponding financial products.
- Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
- Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.
- Learn about extensions that have recently become increasingly important: default risk, multiple yield curves, etc.

Literature

Prerequisites / notice
- Option pricing and hedging for equity markets as covered, e.g., in "Mathematical Foundations for Finance".
- Itô calculus.

Master Thesis
see www.oec.uzh.ch/studies/general/theses/oec_en.html

Quantitative Finance Master - Key for Type

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<tr>
<th>Key for Type</th>
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<th>W</th>
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<tr>
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<td>Courses outside the curriculum</td>
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<tr>
<td>Eligible for credits</td>
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<td>Suitable for doctorate</td>
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Key for Hours

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<th>U</th>
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<td>lecture</td>
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<td>lecture with exercise</td>
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<tr>
<td>exercise</td>
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<td>seminar</td>
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<td>colloquium</td>
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<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Spatial Development and Infrastructure Systems Master

1. Semester

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<td>101-0467-01L</td>
<td>Transport Systems</td>
<td>O</td>
<td>6 credits</td>
<td>4G</td>
<td>U. A. Weidmann, K. W. Axhausen, M. Menendez</td>
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<td>Only for master students, otherwise a special permission by the lecturers is required.</td>
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<tr>
<td>Abstract</td>
<td>History, impact and principles of the design and operation of transport systems</td>
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<tr>
<td>Objective</td>
<td>Introduction of the basic principles of the design and operation of transport systems (road, rail, air) and of the essential pathways of their impacts (investment, generalised costs, accessibility, external effects)</td>
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<tr>
<td>Content</td>
<td>Transportation systems and land use; network design; fundamental model of mobility behaviour; costs and benefits of mobility; transport history</td>
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<td></td>
<td>Characteristics of rail systems, bus systems, cable cars and funiculars, unconventional systems; introduction to logistics; fundamentals of rail freight transports; freight transport systems; intermodal transportation</td>
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<tr>
<td>Lecture notes</td>
<td>Lecturer notes and slides as well as hints to further literature will be given during the course.</td>
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<td>Prerequisites / notice</td>
<td>Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.</td>
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Sustainable Spatial Development I

<table>
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<tr>
<td>Abstract</td>
<td>The lectures impart important knowledge for solving spatial relevant conflicts and problems. Case studies will be used to demonstrate the implementation in practice.</td>
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<tr>
<td>Objective</td>
<td>Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation. The concept of sustainable development in spatial planning leads necessarily to an efficient management of the resources, especially regarding the resource land. The basics of this important discipline will be the subject of this lecture, which is therefore organised in three parts:</td>
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<td>- Inner development</td>
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<td></td>
<td>- Integrated spatial and infrastructure development</td>
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<td></td>
<td>Network layout, and its impact on road traffic. Traffic control systems for urban and inter-urban areas. Fundamentals of road safety and infrastructure maintenance.</td>
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<td>Content</td>
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<td>Tasks of Spatial Planning and development</td>
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<td>Issues of local and supra-local interest</td>
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<td>Recurring spatial changes, impacts and key figures</td>
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<td>Formal and informal instruments and procedures in spatial planning</td>
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<td>Spatial Design - Ideas about the future</td>
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<td></td>
<td>Reasoning and assessing the situation in spatial planning</td>
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<td>Spatial planning as a sequence of decisions and interventions</td>
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<td>Process and procedures management</td>
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<td>Focus issues - Inner development before external development</td>
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<td>Focus issues - Cross-border tasks</td>
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<td>Focus Issues - Integrated spatial and infrastructure development</td>
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<tr>
<td>Lecture notes</td>
<td>Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.</td>
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Landscape Planning and Environmental Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0347-00L</td>
<td>Landscape Planning and Environmental Systems</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Grêt-Regamey</td>
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<td></td>
<td>Only for master students, otherwise a special permission by the lecturers is required.</td>
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<tr>
<td>Abstract</td>
<td>In the course, methods for the identification and measurement of landscape characteristics, as well as measures and implementation of landscape planning are taught. Landscape planning is put into the context of the environmental systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.</td>
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<tr>
<td>Objective</td>
<td>The aims of this course are:</td>
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<td></td>
<td>1) To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna).</td>
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<td>2) To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.</td>
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<td>3) To show the importance of ecosystem services.</td>
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<td>4) To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).</td>
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<td>5) To identify and measure the characteristics of landscape.</td>
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<td>6) Learn how to use the instrument of GIS appropriately in landscape planning.</td>
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<tr>
<td>Content</td>
<td>In this course, the following topics are discussed:</td>
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<td>- Definition of the concept of landscape</td>
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<td>- Landscape change</td>
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<td>- Landscape planning</td>
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<td></td>
<td>- Methods, instruments and aims of landscape planning (politics)</td>
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<td>- Socio-political questions of the future</td>
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<td></td>
<td>- Environmental systems, IUCN Red List, ecological connectivity</td>
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<td>- Urban landscape services</td>
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<td>- Practice of landscape planning</td>
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<td></td>
<td>- Use of GIS in landscape planning</td>
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<tr>
<td>Lecture notes</td>
<td>No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (exercises)). An combination of courses is recommended.</td>
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</table>
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by reading data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

The course will be held in English and no prior knowledge on R is required.

The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

The course is composed of a lecture part, providing the theoretical knowledge, and an applied part, in which students develop their own models.

- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning
- Basic combinatorial optimization problems.

The course is composed of a lecture part, providing the theoretical knowledge, and an applied part, in which students develop their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

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

The course will be held in English and no prior knowledge on R is required.

The slides of the lecture are provided electronically.

The course is composed of a lecture part, providing the theoretical knowledge, and an applied part, in which students develop their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

- Understanding of algorithms and their implementations commonly used in transport planning
- Knowledge of methods and algorithms commonly used in transport planning
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning
- Basic combinatorial optimization problems.

The course will be held in English and no prior knowledge on R is required.

The slides of the lecture are provided electronically.

The course is composed of a lecture part, providing the theoretical knowledge, and an applied part, in which students develop their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

The course will be held in English and no prior knowledge on R is required.

The slides of the lecture are provided electronically.

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The course will be held in English and no prior knowledge on R is required.

The slides of the lecture are provided electronically.
101-0427-01L  System and Network Planning  W  6 credits  4G  U. A. Weidmann

Abstract  Public transports in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile

Objective  Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them

Content  (1) Fundamentals of system and network planning: Mobility and transport systems; public transport systems; customer needs versus supply characteristics of regular services. (2) System and network planning in public passenger services: Goals of the system and network planning; generic planning process; demarcation, analysis of the situation, setting of targets; design of public transport services; evaluation and optimization; system planning. (3) Public transport services: long distance service offers; suburban and urban service offers; regional and local service offers; access to public transport and the last mile.

Lecture notes  A script in German will be provided for the course. The slides are made available.

Literature  References to technical literature will be included in the course script. An additional list of literature will be given during the course.

No remarks.

101-0499-00L  Basics in Air Transport  W  4 credits  3G  P. Wild

Ab HS15 Belegung im 1. Semester statt im 3. Semester des Masterstudiums empfohlen, da ab FS16 eine neue LV Management des Luftverkehrs (Management of Air Transport) angeboten werden wird

Abstract  The course explains main principles of air transport in general and elaborates on simple interdisciplinary topics. Since working on broad topics like aerodynamics, manufacturers, airport operation, business aviation, business models etc. the students gets a good overview in air Transportation.

Objective  Understand and explain basics, principles and contexts in the broader air transport industry.

Content  Lay the foundation of working in or with the air transport industry.

Weekly: 1h independent preparation; 2h lectures and 1 h training with an expert in the respective field

Concept: This course will be taught as Aviation I. A subsequent course is under evaluation.

Content: Transport as part of the overall transportation scheme; Aerodynamics; Aircraft (A/C) Designs & Structures; A/C Operations; Law Enforcement; Maintenance & Manufacturers; Airport Operations & Planning; Customs & Security; ATC & Airspace; Air Freight; General Aviation; Business Jet Operations; Business models within Airline Industry; Military Operations.

Guided tour: This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

Examination: written, 60 min, with open book

Literature  Literature will be provided by the lecturers respective there will be additional Information upon registration

We will also use English papers

101-0337-01L  Site and Project Development  W  3 credits  2G  G. Nussbaumer

Abstract  The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester exercise covers a specific major project and serves as the semester grade (project report and presentation).

Objective  Objectives of the lecture are:

1) Get knowledge of comprehensive and multifunctional large-scale projects and their problem areas
2) Get deepened knowledge in selected fields (site analysis, market analysis, project development, cooperative planning, participation processes)
3) Practical orientation, insight into occupational fields
4) Independent acquirement and acquisition of theoretical knowledge

Literature  http://cran.r-project.org/doc/manuals/R-intro.pdf available online

Prerequisites / notice  The course will be held in English and no prior knowledge on R is required.
The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. Technical presentations, lectured by scientific staff of the division of Planning of Landscape and Urban Systems PLUS, as well as invited guest referees, treat different subjects.

The subjects are:
- Site and market analysis
- Real estate development
- Project development from the perspective of project developers and investors
- Parking and transportation models
- Cooperative planning, participation processes, mediation

The theory is discussed and illustrated at case studies and exercises. Specific large-scale projects that are currently in the development phase will be discussed, for example, the area Sihl-Manegg in Zürich (GreenCity), or the ex-area Plattenmarkt (Niedfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

Lecture notes
- Handouts of the lectures
- Extracts from relevant scientific articles and theory literature
- Exercise material

Download: http://www.irl.ethz.ch/plus/education

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites</th>
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<tbody>
<tr>
<td>103-0417-02L</td>
<td>Theory and Methodology of Spatial Planning</td>
<td>3</td>
<td>R. Signer, M. Nollert</td>
</tr>
<tr>
<td>051-0363-00L</td>
<td>History of Urban Design I</td>
<td>2</td>
<td>V. Magnago Lampugnani</td>
</tr>
<tr>
<td>851-0707-00L</td>
<td>Space Planning Law and Environment</td>
<td>2</td>
<td>O. Bucher</td>
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Abstract
- Theory and Methodology of Spatial Planning: In order to solve problems in spatial planning it is necessary to explore actions and judge them; finally, one has to argue why a certain option should be preferred to others. Assessments of the situation are the basis for the problems to treat. Specific knowledge, represented in an adequate manner, is required.

Objective
- The participants know the interdependencies between the assessment of a situation, decision making, knowledge and language. They know the nature of a decision dilemma and maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding actor. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.

Content
- Assessment of the situation, decision, language and knowledge are the main parts.

Welcome to the History of Urban Design I course! In this course, students will explore the history of urban design from antiquity to the mid-19th century. The course will cover a wide range of topics, including urban design from the spirit of equality to the colonial module, the construction of the bourgeois city, and the city between Absolutism and Enlightenment. The course will also discuss the role of urban design in the reconstruction of Lisbon and the impact of ideology and speculation on urban design. Further, students will learn about the architectural insertion and plan for the expansion of the city, the construction of the bourgeois city, and the city between Absolutism and Enlightenment. The course will also cover specific large-scale projects that are currently in the development phase, such as the area Sihl-Manegg in Zürich (GreenCity) or the ex-area Plattenmarkt (Niedfeld) Luzern.

Lecture notes
- The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) or at the price of CHF 30.-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

Further recommended literature to consult is listed within the script.

Winter Semester 2015

Download: http://www.irl.ethz.ch/plus/education

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<tr>
<th>Course Code</th>
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<tr>
<td>103-0417-02L</td>
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<tr>
<td>851-0707-00L</td>
<td>Space Planning Law and Environment</td>
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Prerequisites / notice
- History of Urban Design from antiquity to the 19th century

Further information and resources can be found on the course website: http://www.irl.ethz.ch/plus/education
Objective
Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.

Content

Lecture notes
Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999

Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 5.A., Bern 2008

103-0327-00L History of Spatial Planning

Objective
This course aims to provide students with knowledge of the historical background to understand the current spatial structure and to face the current challenges in spatial planning. Social, cultural, and economic forces will be analyzed for the roles they have played in shaping the landscapes and cityscapes and the answers spatial planning had to spatial development. The course focuses on the history of planning ideas, paradigms and approaches. A link is made to current challenges in spatial planning.

Content
Die Veranstaltung gibt einen Überblick über die Geschichte der Raumplanung. Sie möchte das Verständnis für die Ideengeschichte wecken und den historischen Kontext für die gegenwärtige Raumplanung und Raumstruktur vermitteln.

Literature


Kleine Geschichte der Schweiz: Der Bundesstaat und seine Traditionen (edition suhrkamp)


Daniel Kurz: Die Disziplinierung der Stadt - Moderner Städtebau in Zürich 1900 bis 1940. gta Verlag 2008

W+ Handouts of the lectures
- Script
- Exercise material

103-0377-00L Introduction to the Data Analysis Software R

Objective
R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

Content
Reading data from files
Creating and handling R objects such as matrices, vectors and arrays
Plotting data: histograms, boxplots, scattered plots
Writing data to files
Reading raster and vector data
Writing for- and while-loops
Writing your own functions

Lecture notes
Handouts of the lectures and exercises will be distributed available online at http://cran.r-project.org/doc/manuals/R-intro.pdf

Prerequisites / notice
The course will be held in English and no prior knowledge on R is required.

103-0307-00L Multi-Criteria Decision Analysis

Objective
This course will:
1) introduce students to techniques and issues associated with spatial modeling and decision support systems, including analytical techniques that are unique to spatial analysis
2) provide hands-on training in the use of these spatial tools in R while addressing real planning problems.

Content
The emphasis is on concepts, resources, and analysis tools that students can use in science, private companies and government careers.

- Handouts of the lectures
- Script
- Exercise material

Prerequisites / notice
The course will be held in German and English. It is highly recommended to attend the lecture "Introduction to the data analysis software R" ("Einführung in die R Umgebung für Datenanalysen"), providing the basic principles of using the R-Software.

103-0347-01L Landscape Planning and Environmental Systems

Objective
To show the importance of ecosystem services. Analysis and assessment of the complex interactions between landscape elements. To identify and measure the characteristics of landscape. Learn how to use the instrument of GIS appropriately in landscape planning.
851-0707-00L Space Planning Law and Environment
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Abstract
System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.

Objective
Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.

Content

Lecture notes
Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999
Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, S. A., Bern 2008

505-0161-00L Landscape Architecture I

Abstract
Introduction to the history and theory of garden design and landscape architecture. Analysis of the design of historical gardens and landscapes within the cultural background.

Objective
The course covers the basic history and theory of garden design and landscape architecture from its beginnings to the 21st century. The course aims to raise awareness of a changing perception of nature and landscape.

Content
The lecture series on History and Theory of Garden Design and Landscape Architecture deals with the historical development of designed nature, from the beginnings of cultural landscapes and gardens to 21st century landscape architecture. In the analysis of each era, the focus is on the spatial and cultural relationship between the garden, the city and the landscape, as well as the changing perceptions of nature and its representation.

Lecture notes
No script. Handouts and learning material will be provided.

Literature
A reading list will be provided for the exams.

Prerequisites / notice
General Information for the Final Exam: Bachelor students: Relevant for the examination will be the content of the lectures, the handouts and literature provided by the Chair. The lecture series is conceived as a yearlong course. Since the written session examination will test knowledge from both semesters, it is necessary to fully attend the lectures of both courses. The themes of the examination will be announced at the end of the semester. The Chair will provide scripts and literature available for download.

Exchange students or students from other departments: Students, who are attending only one semester, may pass the oral examination. Handouts and literature will also be provided for this purpose. The students are additionally requested to contact the Chair.

701-1631-00L Foundations of Ecosystem Management

Abstract
This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

Objective
Students should be able to
a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales,
b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

Content
Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Lecture notes
No script

Literature

Abstract
Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:
- Risk analysis - What can happen?
  - Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
  - Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
- Risk assessment - What are the acceptable levels of risk?
  - Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
  - Explain causes for conflicts between risk perception and risk analysis.
- Risk management - What steps should be taken to manage risks?
  - Explain how various hazard mitigation approaches reduce risk.
  - Describe hazard scenarios as a base for adequate dimensioning of control measures.
  - Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
  - Explain the principles of risk-governance.

Content
Die Vorlesung besteht aus folgenden Bildern:
1) Einführung ins Vorgehenskonzept (1W)
2) Risikoanalyse (6W + Exkursion) mit:
   - Systemabgrenzung
   - Gefahrenbeurteilung
   - Expositionss- und Folgenanalyse
3) Risikobewertung (2W)
4) Risikomanagement (2W + Exkursion)
5) Abschlussbesprechung (1W)

Objective
The lecture imparts profound knowledge of energy- and environment-related difficulties of the intersection of energy and transportation with focus on the motorized individual traffic. The students gain the ability to approach energy- and environment-related problems with special consideration of the demand side, and to evaluate possible solutions. 

Main topics are:
1. Fundamentals of energy use in the transportation sector, today's present state and future developments.
2. Technical potentials for the reduction of greenhouse gas (GHG) emissions and the dependence on fossil fuels: Evaluation of (a) alternative fuels, and (b) alternative propulsion systems.
3. The relevance of demand on efforts to reduce GHG emissions and the dependence on fossil fuels.
4. Strategies and measures for influencing the demand side.
Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. The reliability of structural systems is also introduced as well as the reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety factors are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post- and pre-post risk assessment methods are presented. Bayesian networks are introduced as a generic numerical tool for solving such problems. The course also includes a tutorial using a software dedicated to real world structural reliability analysis.

The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.

The course will be held in English and no prior knowledge on R is required.

The course content is divided into three main parts:

1. **Probability and Random Variables**
   - Probability theory
   - Random variables and vectors
   - Dependence and correlation

2. **Reliability Analysis**
   - Failure modes and effects analysis (FMEA)
   - Reliability indices
   - Monte Carlo simulation

3. **Risk Analysis**
   - Bayesian decision making
   - Risk assessment methods

**Prerequisites / notice**

The course will be held in English and no prior knowledge on R is required.

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**Introduction to the Data Analysis Software R**

R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

**Objective**

The basic information and tools to be used to make decisions with respect to existing infrastructure.

**Content**

- Reading data from files
- Creating and handling R objects such as matrices, vectors and arrays
- Plotting data: histograms, boxplots, scattered plots
- Writing data to files
- Reading raster and vector data
- Writing for- and while-loops
- Writing your own functions

**Lecture notes**

Handouts of the lectures and exercises will be distributed.

**Literature**

“Introduction to R” by W. N. Venables and D. M. Smith

available online at http://cran.r-project.org/doc/manuals/R-intro.pdf

**Prerequisites / notice**

The course will be held in English and no prior knowledge on R is required.

**Infrastructure Maintenance Processes**

This course provides an introduction to:

- how to model the changes in infrastructure objects over time,
- how to monitor the changes and assess the benefits of interventions, and
- how to intervene to improve infrastructure performance and to assess the benefits of interventions, and
- how to model the changes in stakeholders interests over time.

**Objective**

To provide the basic information and tools to be used to make decisions with respect to existing infrastructure.

**Content**

- Deterioration
  - manifest and latent processes,
  - modeling
- Monitoring
  - non-destructive and destructive techniques,
  - evaluation of benefits of monitoring
- Intervention
  - types of intervention,
  - evaluation of benefits of intervention
- Benefits
  - modeling of stakeholder benefits over time

**Lecture notes**

All necessary materials (e.g. transparencies and hand-outs) will be handed out at the beginning of each class.

**Literature**

Appropriate reading material will be assigned when necessary.

**Structural Reliability and Risk Analysis**

Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing, and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment.

The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.

Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro- codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety factors are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post- and pre-post risk assessment methods are presented. Bayesian networks are introduced as a generic numerical tool for solving such problems. The course also includes a tutorial using a software dedicated to real world structural reliability analysis.

**Prerequisites / notice**

Basic course on probability theory and statistics.
Objective
Part 1: The students shall acquire basic knowledge of the public law concerning civil engineering: space management, conception of buildings, protection of the environment, procedures
Part 2: The students shall acquire basic knowledge of the private law concerning civil engineering

Content
Teil 1: Jede Lektion behandelt für ein bestimmtes Stadium des Projekts ein Thema des öffentlichen Baurechts wie Bau- und Zonenordnungen, Quartierpläne, Umweltverträglichkeitsprüfungen, Baubewilligungsverfahren etc.
Teil 2: Grundzüge des privaten Baurechts wie Abnahme und Genehmigung von Bauwerken, Vollmacht des Architekten / Ingenieurs zu Rechtsbehandlungen namens des Bauherrn, Mängelrüge im Bauwesen, Mehrheit ersatzpflichtiger Baubeteiligter, Generalkaufleutevertrag, Haftung des Bauunternehmers, Handwerkerpfandrecht, Grundzüge der SIA-Norm 118, Baukonsortium, technische Normen, internationale Bauverträge, Architekten / Ingenieure als Gerichtsexperten, Aspekte des Bauzivilprozesses

Lecture notes
D. Trümpy: Tafeln zu den Grundzügen des schweizerischen Bauvertragsrechts (Vorlesungsunterlage)
H. Briner: Tafeln zu den Grundzügen des öffentlichen Raumplanungs-, Bau- und Umweltrechts (Vorlesungsunterlage)

Literature
- Stöckli P./Siegenthaler Th. (Hrsg.) Die Planerverträge, Schulthess 2013
- Gauch Peter, Werkvertrag, 5. Auflage, Schulthess 2011

Prerequisites / notice
Die Teilnehmer sollen stets ein Exemplar der SIA-Norm 118, der SIA-LHO 103 sowie die Gesetzesausgaben von OR und ZGB bei sich haben.

3. Semester

Major Courses

Major in Transport Planning

Number Title Type ECTS Hours Lecturers
101-0439-00L Introduction to Economic Policy - A Case Study Approach with Cost Benefit Analysis in Transport W 6 credits 4G K. W. Axhausen, R. Schubert

Abstract
The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.

Objective
Familiarity with the essential methods of project appraisal

Content
Cost-Benefit-Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety

Lecture notes
Handouts

Literature


364-0517-00L Urban and Spatial Economics W 3 credits 2V R. H. van Nieuwkoop

Abstract
This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.

Objective
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

Content
Outline of Lectures

Topic 1: Why do cities exist?
Topic 2: The Basic Muth-Mills model
Topic 3: The New Economic Geography
Topic 4: Business demand for land and Von Thünen's model
Topic 5: Urban spatial structure
Topic 6: Land use control
Topic 7: City size and city growth
Topic 8: Traffic externalities and congestion
Topic 9: Public transport

Lecture notes
Textbook
- Cities, agglomeration and spatial equilibrium by E. L. Glaeser, 2008, Oxford University Press.
- The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.

363-0445-00L Logistics, Operations and Supply Chain Management I W 3 credits 2G P. Schönsleben, E. Scherer Casanova

Abstract
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

**Objective**

Strategic and tactical concepts in logistics, operations, and supply chain management: Conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the MRP II / ERP concept; business processes and methods; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.

**Content**


This book also serves as textbook for LOS II (spring term) as well as ERP and SCM software systems (autumn term). In addition, powerpoint-handouts and documents for case studies.

**Literature**

As for the lecture of the 3rd week (BEMAD, a much-liked Business Engineering and Management Ability Development game), this lecture (of Oct. 1) will follow a specific schedule in specific rooms. The schedule will be presented at Sept. 17 during the 1st lecture.

Due to the big number of students, about half of the students will play this game, instead of Oct. 1, at Friday afternoon, Oct. 2. Please be available. Thank you for your help in this matter.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0445-02L</td>
<td>Logistics, Operations, and Supply Chain Management (Additional Cases)</td>
<td>W</td>
<td>1</td>
<td>2A</td>
<td>P. Schönslében</td>
</tr>
<tr>
<td>101-0491-00L</td>
<td>Agent Based Modeling in Transportation</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>F. Ciani, R. Waraich</td>
</tr>
</tbody>
</table>

**References to technical literature will be included in the course script. An additional list of literature will be given during the course.**

**Prerequisites**

Students have some experience with some high level programming language (i.e. C, C++, Fortran or Java).

There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java).

**Additional relevant readings, mostly scientific articles, will be recommended throughout the course.**

### Major in Transport Systems

<table>
<thead>
<tr>
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<tr>
<td>101-0449-00L</td>
<td>Management, Marketing, Quality</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>U. A. Weidmann</td>
</tr>
<tr>
<td>101-0479-00L</td>
<td>Safety and Reliability of Railway Systems</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>U. A. Weidmann, O. Fink, M. Montigel</td>
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</tbody>
</table>

**Prerequisites**

Lectures System and Network Planning as well as Systems Dimensioning and Capacity recommended.

<table>
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<tr>
<th>Date</th>
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</table>

**Abstract**

Transport and administrative policy, international and national regulation, business management of public transport companies, marketing, advertising and pricing; quality management

**Objective**

Comprehension of the transport and administrative policy as well as the regulation of public transport companies. To develop a full understanding of the three important public transport system operations management processes: (1) Business management; (2) Marketing; (3) Quality control. The course will teach essential working techniques in each of these processes.

**Content**

(1) Transport and administrative policy: Goals of the state related to public transports, governmental activities in public transport, regulation.

(2) Business management in public transport enterprises: goals of public transport companies, goals of the business management; management of public transport on the different management levels, business organization. (3) Marketing, advertising and pricing: Fundamentals and goals; marketing strategies and concepts in public transports; marketing tools; putting marketing into action. (4) Quality control: Quality in transport systems; goals of quality management; structuring quality control measures; collecting quality data in an operating service; use of quality control systems for service optimization.

**Lecture notes**

Course notes will be provided in German. Slides will be made available.

**Literature**

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

**Prerequisites**

Lectures System and Network Planning as well as Systems Dimensioning and Capacity recommended.
Abstract
Railway safety policies and safety concepts, command and control technologies for railways, optimization systems, European Train Control System, reliability availability maintainability safety (RAMS) of railway systems.

Objective
The students comprehend the main principles of safety, reliability and optimization for railway systems and understand the basic concepts of command and control technologies for railways.

Content
Railway safety strategies
- Safety in public transport
- Safety relevant characteristic of railway transport
- Safety requirements for railway transport
- Safety concepts

Command and control technologies for railway systems
- protective functions
- ensure the sequence-spacing of trains
- ensure route protection
- ensure level crossing protection
- technical realization for protective functions
- European Train Control System

operational command/control systems
- dispatching
- operational control systems
- concepts of optimization

RAMS for railway systems
- accident investigation methods
- RAMS standards for railways
- risk analysis and hazard control
- RAMS methods
- design principles for availability and safety
- maintenance strategies
- Life Cycle Costs (LCC)
- Human Factor
- safety in long railway tunnels

tutorials in Railway Operation Laboratory
field trip to Siemens Wallisellen (command and control technologies)

Lecture notes
The slides will be provided in German.

Literature
References will be included in the lecture notes. An additional list of literature will be given during the course.

Prerequisites / notice
some of the tutorials will be held at the IVTs Railway Operation Laboratory. The lecture Systems Dimensioning and Capacity is recommended.

363-0445-00L Logistics, Operations and Supply Chain Management I W 3 credits 2G P. Schönsleben, E. Scherer Casanova

Abstract
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Objective
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

363-0445-02L Logistics, Operations, and Supply Chain Management I (Additional Cases) W 1 credit 2A P. Schönsleben

Abstract
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Objective
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

364-0517-00L Urban and Spatial Economics W 3 credits 2V R. H. van Nieuwkoop

Abstract
This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.

Prerequisite: one semester in microeconomics.

Objective
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

Content
Outline of Lectures
- Topic 1: Why do cities exist?
- Topic 2: The Basic Muth-Mills model
- Topic 3: The New Economic Geography
- Topic 4: Business demand for land and Von Thünen's model
- Topic 5: Urban spatial structure
- Topic 6: Land use control
- Topic 7: City size and city growth
- Topic 8: Traffic externalities and congestion
- Topic 9: Public transport

Lecture notes
Textbook
o Urban Economics by Arthur O'Sullivan, McGraw-Hill.

Ancillary Texts
o Cities, agglomeration and spatial equilibrium by E. L. Glaeser, 2008, Oxford University Press.

101-0258-00L River Engineering

Abstract
Main subjects treated:
- Fundamentals (e.g. sediment sampling methods), alluvial channel hydraulics, incipient motion, bed forms, bed load and suspended load, sediment budget and morphological changes, river morphology, scour, river management concepts and selected measures (e.g. bank and bed protection works).
- A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.

Objective
The students shall
- be able to describe quantitatively the interrelation between discharge, sediment transport and channel evolution
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration

Content
The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, of bed load and suspended load transport are treated.

In the second part of the lecture the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of bed forms, river morphology and scour.

The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics treated are the stabilization of banks and of the longitudinal profile of rivers.

Lecture notes
Autography River Engineering (in German)

Literature
The autography contains a comprehensive list of references to relevant literature.

Prerequisites / notice
strongly recommended:
- Hydrology, Hydraulics I and Hydraulic Engineering

Traffic Engineering

Number Title Type ECTS Hours Lecturers
101-0469-00L Road Safety W 6 credits 4G H. Schüller, A. Simma, S. Skeledzic

Abstract
The collection and the methods of statistical and geographical analysis of road accidents are important fundamentals of this course. Safety Aspects in design of urban roads are discussed and measures for improving the safety situation are presented. Procedures of infrastructure safety management for administrations and police are another topic.

Objective
Imparting knowledge base about road safety and the event of accident, presenting possibilities to increase road safety

Content
Accident origin, collection of road accidents, statistical (descriptive and multivariate, accident prediction models) and geographical analysis of road accidents, risk analysis and rehabilitation measures, road safety instruments for infrastructure with focus on road safety audit, Swiss and international transport policy

Literature

Further literature: will be presented during the course

101-0492-00L Simulation of Traffic Operations W 3 credits 2G H. He

Abstract
The course introduces basics of microscopic simulation of traffic operations, including simulation model development, calibration, validation, data analysis, identification of strategies for improving traffic performance, and evaluation of such strategies. The modelling software used is VISSIM.
Objective
The objective of this course is to conduct a realistic traffic engineering project from beginning to end. During the process, students will also familiarize themselves with microscopic traffic simulation, and will use the simulation software for modeling and analyzing the traffic operations in reality. The emphasis is not only on building the simulation model, but also how to evaluate results. The final goal is to make valid and concrete engineering proposals based on the simulation model.

Content
In this course the students will complete a traffic engineering project with microscopic traffic simulator VISSIM. An emphasis will be on traffic signals at intersections.

Specific tasks will include:
1) Building a model with the simulator VISSIM in order to replicate and analyze the traffic conditions measured/observed.
2) Calibrating and validating the simulation model.
3) Redesigning/extending the model to improve the traffic performance.

Lecture notes
The lecture notes and additional handouts will be provided before the lectures.

Literature
Additional literature recommendations will be provided at the lectures.

Prerequisites / notice
There are no pre-requisites for this course. The course Transport Simulation (101-0438-00 G) and previous experience with VISSIM is helpful but not mandatory. In addition, simultaneously taking the course Traffic Engineering (101-0437-00 G) is encouraged.

★★★ Infrastructure Management

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>101-0419-00L</td>
<td>Railway Construction and Maintenance</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>U. A. Weidmann, P. Güldenapfel, M. Kohler, M. J. Manhart, further speakers</td>
</tr>
</tbody>
</table>

Abstract
Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods

Objective
The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forecast are shown. State-of-the-art maintenance strategies and technologies are presented.

Content
Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods

Lecture notes
The slides will be made available.

Literature
A list with related technical literature will be handed out.

Prerequisites / notice
The lecture Railway Infrastructures (Transportation II) is recommended.

101-0509-00L Infrastructure Management Systems  W  3 credits  2G  B. T. Adey

Abstract
The course will provide an introduction to the human and computerized systems used to manage infrastructure.

Objective
Upon completion of the course students will have the fundamental knowledge required
- to identify and model the processes used in organizations to manage infrastructure,
- to establish benchmarks that can be used to measure the performance of organizations that manage infrastructure, and
- to evaluate organizations that manage infrastructure

Content
- Introduction
- Organisation types used to manage infrastructure
- Processes used in organizations that manage infrastructure
- Methods used to evaluate organizations that manage infrastructure, including the establishment of appropriate benchmarks

Lecture notes
Appropriate reading / and study material will be handed out during the course. Transparencies will be handed out at the beginning of each class.

Literature
Appropriate literature will be handed out when required.

★★ Interdisciplinary Project Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0489-02L</td>
<td>Interdisciplinary Project</td>
<td>O</td>
<td>12</td>
<td>24A</td>
<td>B. T. Adey</td>
</tr>
</tbody>
</table>

Abstract
Working on a concrete interdisciplinary task on spatial development and infrastructure systems

Objective
Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content
The project work is supervised by a professor. Students can choose from different subjects and tasks.

Electives
The entire course programs of ETH Zurich and University Zurich are open to the students to individual selection. The students have themselves to check whether they meet the admission requirements for a course.

★★ List of Electives Recommended by the Degree Programme

Students having enroled for 851-0703-03 earlier (i.e. bachelor's degree programme or as additional requirement for master's degree programme) cannot enrol for this again during master's degree programme.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0327-00L</td>
<td>History of Spatial Planning</td>
<td>W+</td>
<td>1</td>
<td>1V</td>
<td>M. Koll-Schretzenmayr</td>
</tr>
</tbody>
</table>

Abstract
The course examines the patterns of cleavage, conflict, convergence of interest, and consensus that have structured spatial planning.

Objective
This course aims to provide students with knowledge of the historical background to understand the current spatial structure and to face the current challenges in spatial planning.

Content
Social, cultural, and economic forces will be analyzed for the roles they have played in shaping the landscapes and cityscapes and the answers spatial planing had to spatial development. The course focuses on the history of planning ideas, paradigms and approaches. A link is made to current challenges in spatial planning.

Content
Die Veranstaltung gibt einen Überblick über die Geschichte der Raumplanung. Sie möchte das Verständnis für die Ideengeschichte wecken und den historischen Kontext für die gegenwärtige Raumplanung und Raumstruktur vermitteln.
The course will provide an introduction to the human and computerized systems used to manage infrastructure.

Appropriate reading / study material will be handed out during the course.

R. Boes

Appropriate reading material will be assigned when necessary.

Infrastructure Management Systems

W 3 credits 2G B. T. Adey

Abstract
The course will provide an introduction to the human and computerized systems used to manage infrastructure.

Objective
Upon completion of the course students will have the fundamental knowledge required to deepen knowledge on special aspects in hydraulic engineering and to understand the procedures and the planning sequence of hydropower projects.

Content
Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or natural hazards by impulse waves, the hydraulics of river flows, spillways and intake structures at dams and weirs, hydropower and ecology like fish-ecological aspects at low-head hydropower plants and eco-hydraulics like flow-vegetation interaction. Another focus will be put on typical approaches and procedures in the planning process of hydropower projects.

Lecture notes:

Lecture notes/handouts will be available online.

Literature:
External speakers will present current topics and projects in Switzerland and abroad.

Advanced Environmental, Social and Economic Assessments

W 6 credits 3G+2U+2P A. E. Braunschweig, S. Hellweg, S. Pfister, R. Frischknecht

Abstract
This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.

Objective
In particular, students completing the course should have the ability to:

- judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of...", students will learn to:
- describe key sustainability problems of the current economic system and measuring units.
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance)

- explain the pros and cons of single score env. assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by applying analysis of variance and experimental design.

Thematic map types (focus on quantitative information)

Own script and instructions will be distributed.

Lecture notes

Part I (Advanced Environmental Assessments)

- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multiooutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Case Studies

Part II (Implementation of Environmental and other Sustainability Goals):

- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
  - The concept of 'Continuous Improvement'
  - Life Cycle Costing, Life Cycle Management
- environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance), based on practical examples of companies and new concepts
  - single score env. assessment methods (Swiss ecopoints)
  - stakeholder management and sustainability oriented communication
  - an intro into sustainability issues of supply chain management

Students will get small exercises related to course issues.

Lecture notes

Part III (Computer Lab): this is an exercise and software lab to apply the methods from Part I and II of this lecture.

Lecture notes

Thematic Cartography

Abstract

Thematic map types (focus on quantitative information), analysis of themes and application, base maps, generalisation

Objective

Knowing of most important thematic map types.

Ability to design adequate thematic maps from statistical data.

Content

Thematic map types (focus on quantitative information)

Analysis of themes and application using adequate structural types

Use of adequate base maps

Generalisation of thematic maps

Dynamic thematic maps

Literature


Prerequisites / notice

Further information at http://www.karto.ethz.ch

Prerequisite: Cartography Introduction

Part III (Computer Lab): this is an exercise and software lab to apply the methods from Part I and II of this lecture.

Lecture notes

Cartography III

Abstract

Basic methods, technologies, scripting, and systems for interactive web mapping projects in the internet cartography

Objective

Gain knowledge about basic methods, technologies, scripting, and systems for interactive web mapping projects. Assessment of existing products regarding production methods. Definition of useful methods for Web-based map projects.

Content

- Web mapping
- Web Map Services (WMS)
- User Interface design
- Symbolisation
- Programming
- Java Script
- Debugging
- Map production using GIS data
- 3D-applications in cartography

Literature


Prerequisites / notice

Applied Analysis of Variance and Experimental Design

Abstract

Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Lecture notes: see website

Literature:
Overview of the technical characteristics of railway systems

M. Stauffacher

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects.Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

At the end of the course students should:

- Motivation of young engineers to start a career in the railway industry or with railway operators
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Interrelationship between different fields of engineering sciences (mechanics, electro and information technology, transport systems)

Railway Systems I

M. Meyer

Basic characteristics of railway vehicles and their interfaces with the railway infrastructure:
- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signalling systems
- Traffic control and maintenance

- Overview of the technical characteristics of railway systems
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Motivation of young engineers to start a career in the railway industry or with railway operators
Further information is available at http://www.hertig.ethz.ch/courses.htm

Within the scope of the lecture "Traffic Law / Traffic Commercial Law", besides an introduction into the legal basis of the national and international traffic, the main interest will be laid on actual political and economical questions and problems with respect to traffic (e.g. financing of traffic, road pricing, rail reform, air traffic vs. environment law etc.). With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly.

Lecture notes
Script will be distributed during the lecture.

Environmental Management  W  2 credits  2G  R. Züst

Abstract
An environmental management system has the objective to continuously improve the environmental performance of the activities, products and services of a company. The company has to introduce different management procedures. The goal of this lecture is to provide basics and specific procedure to implement the environmental dimension in the planning and decision making processes of an organisation.

Objective
Overview on environmental management and environmental management systems, general methods and principles.

Content
Introduction to environmental management / environmental management systems, energy and material flows; economical and ecological problems in industry; characterisation of an environmental management system; overview on the ISO 14001 ff. series; methods for environmental evaluation and assessment; integrated management systems; planning methodology and life-cycle-design design; planning exampl

Lecture notes
Information about environmental management and environmental management systems will be provided by a CD or mail.

Literature
A list with literatures and links will be provided

Prerequisites / notice
Delivery of a case study, worked out in groups. Language: Teaching in English on request.

Fundamentals of Natural Hazards Management  W  3 credits  3G  H. R. Heinimann, B. Krummenacher, S. Löw

Abstract
Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.

Objective
Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:
- Risk analysis - What can happen?
  - Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
  - Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
- Risk assessment - What are the acceptable levels of risk?
  - Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
  - Explain causes for conflicts between risk perception and risk analysis.
- Risk management - What steps should be taken to manage risks?
  - Explain how various hazard mitigation approaches reduce risk.
  - Describe hazard scenarios as a base for adequate dimensioning of control measures.
  - Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
  - Explain the principles of risk-governance.

Content
Die Vorlesung besteht aus folgenden Blöcken:
1) Einführung ins Vorgehenskonzept (1W)
2) Risikoanalyse (6W + Exkursion) mit:
   - Systemabgrenzung
   - Gefahrenbeurteilung
   - Expositions- und Folgenanalyse
3) Risikobewertung (2W)
4) Risikomanagement (2W + Exkursion)
5) Abschlussbesprechung (1W)

Master Thesis

Before starting the Master's thesis, students must have:
- obtained the Bachelor's degree;
- fulfilled all specified admission conditions, if any;
- acquired at least 90 credits in the Master's programme, including 12 credits in the area of the interdisciplinary project.

Abstract
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

Objective
To work independently and to produce a scientifically structured work.

Content
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.
### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</table>

### ECTS

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Computational Science and Engineering Bachelor

First Year Courses

Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
401-0231-10L | Analysis I | | 8 credits | 7G | A. Iozzi

Abstract: Calculus of one variable: Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations

Objective: Einführung in die Grundlagen der Analysis

Lecture notes: Christian Blatter: Ingenieur-Analysis (Kapitel 1-3)

401-0151-00L | Linear Algebra | | 4 credits | 3G+2U | V. C. Gradinaru

Abstract: Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.

Objective: Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte


252-0023-00L | Discrete Mathematics | | 8 credits | 5V+2U | U. Maurer

Abstract: Content: Mathematical reasoning and proofs, abstraction. Sets, relations (e.g. equivalence and order relations), functions, combinatorics, (un-)countability, graph theory, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi).

Objective: The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g. in cryptography, coding theory, and algorithm theory.

Content: See course description.

Lecture notes: available (in english)

252-0835-00L | Computer Science I | | 4 credits | 2V+2U | F. O. Friedrich

Abstract: The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required.

Objective: Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the scene" when a program is translated and executed.

Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.

Content: The course covers fundamental data types, expressions and statements, (limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphism, simple dynamic data types are introduced as examples.

In general, the concepts provided in the course are motivated and illustrated with algorithms and applications.

Lecture notes: A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page.


Prerequisites / notice: From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it.

Examination is a one hour-long written test.

227-0003-00L | Digital Circuits | | 4 credits | 2V+2U | G. Tröster


Objective: Provide basic knowledge and methods to understand and to design digital circuits and systems.

Content: Digital and analogue signals and their representation. Boolean algebra, circuit analysis and synthesis, the MOS transistor, CMOS logic, static and dynamic behaviour, tristate logic, Karnaugh-Maps, hazards, binary nuber systems, coding, Combinational and sequential circuits and systems (boolean algebra, K-maps, etc.). Memory building blocks and memory structures, programmable logic circuits. Finite state machines, architecture of microprocessors.

Lecture notes: Lecture notes for all lessons, assignments and solutions.

Textbook: http://www.ife.ee.ethz.ch/education/Digitaltechnik

Literature: Literature will be announced during the lessons.

Prerequisites / notice: No special prerequisites

Basic Courses

Block G1

Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
401-0353-00L | Analysis III | | 4 credits | 2V+1U | P. S. Jossen

Abstract: In this lecture we treat problems in applied analysis. The focus lies on the simplest cases of three fundamental types of partial differential equations of second order: the Laplace equation, the heat equation and the wave equation.
1.) Klassifizierung von PDE's
- linear, quasilinear, nicht-linear
- elliptisch, parabolisch, hyperbolisch

2.) Quasilineare PDE
- Methode der Charakteristiken (Beispiele)

3.) Elliptische PDE
- Bsp: Laplace-Gleichung
- Harmonische Funktionen, Maximumsprinzip, Mittelwerts-Formel.
- Methode der Variablenseparation.

4.) Parabolische PDE
- Bsp: Wärmeleitungsgleichung
- Bsp: Inverse Wärmeleitungsgleichung
- Methode der Variablenseparation

5.) Hyperbolische PDE
- Bsp: Wellengleichung
- Formel von d'Alembert in (1+1)-Dimensionen
- Methode der Variablenseparation

6.) Green'sche Funktionen
- Rechnen mit der Dirac-Deltafunktion
- Idee der Green'schen Funktionen (Beispiele)

7.) Ausblick auf numerische Methoden
- 5-Punkt-Diskretisierung des Laplace-Operators (Beispiele)

Literatur

Zusätzliche Literatur:
Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, Kap. 8, 11, 16 (sehr gutes Buch, als Referenz zu benutzen)
Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen", vdf Hochschulverlag AG an der ETH Zürich.
G. Felder: "Partielle Differentialgleichungen"
http://www.math.ethz.ch/u/felder/Teaching/PDG

Prerequisites / notice
Prerequisites: Analysis I and II, Fourier series (Komplexe Analysis)
The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs.

Following the course should enable students to:

1. answer non-trivial queries on existing relational databases by formulating (entry-level) SQL statements, as well as to add new database content and to update or delete existing content,

2. formalize facts as perceived in the real world in terms of the entity-relationship model, and derive a set of normalized relations (tables) which define the structure of a relational database.

3. explain how a database management system (DBMS) essentially works and what kind of services it provides.

4. understand how a web search engine such as Google basically works.

5. know and apply the core concepts to structure and query XML-documents.

6. list the characteristics of “Big Data” and know the basics of processing “Big Data”.

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

Prerequisites / Literature


401-0647-00L Introduction to Mathematical Optimization O 5 credits 2V+1U R. Zenklusen

Abstract

Introduction to basic techniques and problems of mathematical optimization.

Objective

The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

Content

Topics covered in this course include:

- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

Prerequisites / Literature

Information about relevant literature will be given in the lecture.

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

### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

**Abstract**
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective**
Introduction to HPC for scientists and engineers

**Fundamental of:**
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

**Content**
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

**Lecture notes**
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

### Fields of Specialization

#### Astrophysics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-7851-00L</td>
<td>Theoretical Astrophysics (University of Zurich)</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>R. Teysier</td>
</tr>
</tbody>
</table>

**Abstract**
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

**UZH Module Code:** AST512

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

**Literature**
1. "Formation of stars" (S. Stahler and F. Palla - Wiley editions, this is the book on which about half of the classes will be based and photocopies will be organized during first lecture)
2. "Radiative processes in astrophysics" (R. Ribycki and A. Lightman)

**Additional PowerPoint slides will be prepared by the lecturer on these and extra topics (e.g. planet formation).**

**Prerequisites**
Elementary atomic physics, thermodynamics, mechanics, fluid dynamics.

Introduction to astrophysics (preferred but not obligatory).

### Physics of the Atmosphere

<table>
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<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0023-00L</td>
<td>Atmosphere</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>H. Wernli, T. Peter</td>
</tr>
</tbody>
</table>

**Abstract**
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Objective**
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

**Content**
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Lecture notes**
Written information will be supplied.

**Literature**

### Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0004-00L</td>
<td>Computer Simulation in Chemistry, Biology and Physics</td>
<td>W</td>
<td>7 credits</td>
<td>4G</td>
<td>P. H. Hünenberger</td>
</tr>
</tbody>
</table>

**Abstract**
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

**Objective**
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

**Content**
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.
 Fluid Dynamics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0103-00L</td>
<td>Fluid Dynamics II</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>P. Jenny</td>
</tr>
</tbody>
</table>

Abstract: Two-dimensional irrotational (potential) flows: stream function and potential, unsteady flow, aerodynamic concepts.

Vorticity dynamics: vorticity and circulation, vorticity equation, vortex theorems of Helmholtz and Kelvin.

Compressible flows: isentropic flow along stream tube, normal and oblique shocks, Laval nozzle, Prandtl-Meyer expansion, viscous effects.

Objective: Expand basic knowledge of fluid dynamics.

Content: Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Vorticity dynamics: vorticity and circulation, vortex equation, vortex theorems of Helmholtz and Kelvin.

Compressible flows: isentropic flow along stream tube, normal and oblique shocks, Laval nozzle, Prandtl-Meyer expansion, viscous effects.

Lecture notes: Lecture notes are available in German. (See also info on literature below.)

Literature: Relevant chapters (corresponding to lecture notes) from the textbook


Prerequisites / notice: Analysis III, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

 Systems and Control

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0103-00L</td>
<td>Control Systems</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>M. Morari, F. Dörfler</td>
</tr>
</tbody>
</table>

Abstract: Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective: Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.


Lecture notes: Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF).


Prerequisites / notice: Prerequisites: Signal and Systems Theory II.

MATLAB is used for system analysis and simulation.

 Robotics

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>151-0601-00L</td>
<td>Theory of Robotics and Mechatronics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Korba, S. Stoeter, B. Nelson</td>
</tr>
</tbody>
</table>

Abstract: This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Objective: Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotics systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Content: An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

Lecture notes: available.
Prerequisites / notice  The course will be taught in English.

151-0851-00L  Robot Dynamics  ■  W  4 credits  2V+1U  R. Siegwart, M. Hutter, K. Rudin, T. Staehly

Abstract  We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

Objective  The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

Content  The course consists of three parts: First, we will refresh and deepen the student's knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

Prerequisites / notice  The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

Physics

Number  Title  Type  ECTS  Hours  Lecturers
402-0809-00L  Introduction to Computational Physics  W  8 credits  2V+2U  H. J. Herrmann

Abstract  This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell’s equation), Monte Carlo simulations, percolation, phase transitions.


Computational Finance

Number  Title  Type  ECTS  Hours  Lecturers
401-3913-01L  Mathematical Foundations for Finance  W  4 credits  3V+2U  E. W. Farkas, M. Schweizer

Abstract  First introduction to main modelling ideas and mathematical tools from mathematical finance. This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastic used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

Objective  Topics to be covered include
- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô’s formula, Girsanov transformation, Itô’s representation theorem
- Black-Scholes formula

Literature  Lecture notes will be sold at the beginning of the course.

Prerequisites / notice  Prerequisites: Results and facts from probability theory as in the book "Probability Essentials" by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course "Wahrscheinlichkeitstheorie"). For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

401-4657-00L  Numerical Analysis of Stochastic Ordinary Differential Equations  W  6 credits  3V+1U  A. Jentzen

Abstract  Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective  The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content  Generation of random numbers
- Monte Carlo methods for the numerical integration of random variables
- Stochastic processes and Brownian motion
- Stochastic ordinary differential equations (SODEs)
- Numerical approximations of SODEs
- Multilevel Monte Carlo methods for SODEs
- Applications to computational finance: Option valuation

Lecture notes  Lecture Notes will be available.
## Prerequisites / notice

**Prerequisites:**
- Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.
- a) mandatory courses: Elementary Probability, Probability Theory I.
- b) recommended courses: Stochastic Processes.

## Electromagnetics

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<tr>
<td>227-2037-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
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</table>

**Abstract**

Physical modelling plays an important role in the analysis and design of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied.

**Objective**

Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained.

**Content**

Since the fabrication and characterization of micro- and nanostructures is difficult, expensive, and time-consuming, numerical modelling drastically reduced the design process. Although many commercial software packages are available, it is important to know the drawbacks and difficulties of the numerical methods behind them and to be able to validate the results obtained with such packages. First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the problems to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electrodynamics to multiphysics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

## Geophysics

**Recommended combinations:**

- Subject 1 + Subject 2
- Subject 1 + Subject 3
- Subject 2 + Subject 3
- Subject 3 + Subject 4
- Subject 5 + Subject 6
- Subject 5 + Subject 4

### Geophysics: Subject 1

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<tr>
<td>651-4007-00L</td>
<td>Continuum Mechanics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>T. Gerya</td>
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</table>

**Abstract**

In this course, students learn crucial partial differential equations (conservation laws) that are applicable to any continuum including the Earth's mantle, core, atmosphere and ocean. The course will provide step-by-step introduction into the mathematical structure, physical meaning and analytical solutions of the equations. The course has a particular focus on solid Earth applications.

**Objective**

The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth's mantle, core, atmosphere and ocean. By the end of the course, students should be able to write, explain and analyse the equations and apply them for simple analytical cases. Numerical solving of these equations will be discussed in the Numerical Modelling I and II course running in parallel.
A provisional week-by-week schedule (subject to change) is as follows:

**Week 1:** The continuity equation
Theory: Definition of a geological media as a continuum. Field variables used for the representation of a continuum. Methods for definition of the field variables. Eulerian and Lagrangian points of view. Continuity equation in Eulerian and Lagrangian forms and their derivation.
Exercise: Computing the divergence of velocity field.

**Week 2:** Density and gravity
Exercise: Computing density, thermal expansion and compressibility from an equation of state.

**Week 3:** Stress and strain
Theory: Definition and stresses. Deviation of stress, strain and strain-rate tensors. Deviatoric stresses. Mean stress as a dynamic (non-lithostatic) pressure. Stress and strain rate invariants.
Exercise: Analysing strain rate tensor for solid body rotation.

**Week 4:** The momentum equation
Stokes equation of slow laminar flow of highly viscous incompressible fluid and its application to geodynamics. Simplification of the Stokes equation in case of constant viscosity and its relation to the Poisson equation.
Exercise: Computing velocity for magma flow in a channel.

**Week 5:** Viscous rheology of rocks
Theory: Solid-state creep of minerals and rocks as the major mechanism of deformation of the Earth's interior. Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws.
Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

**Week 6:** The heat conservation equation
Exercise: steady temperature profile in case of channel flow.

**Week 7:** Elasticity and plasticity

---

**Content**

**Objective**

In this 13-week sequence, students learn how to write programs from scratch to solve partial differential equations that are useful for Earth science applications. Programming will be done in MATLAB and will use the finite-difference method and marker-in-cell technique. The course will emphasize a hands-on learning approach rather than extensive theory.

**Theory**

- Week 1: Introduction to the finite difference approximation to differential equations. Introduction to programming in MATLAB. Solving of 1D Poisson equation.
- Weeks 5: Conservative finite differences for the momentum equation. "Free slip" and "no slip" boundary conditions. Solving momentum and continuity equations in case of variable viscosity using pressure-velocity formulation with staggered grid.
- Week 7: Advection in 2-D with Marker-in-cell method. Combining flow calculation and advection for buoyancy driven flow.
- Week 9: Solving 2D heat conservation equation in case of constant thermal conductivity with explicit and implicit approaches.
- Week 10: Solving 2D heat conservation equation in case of variable thermal conductivity with implicit approach. Temperature advection with markers. Creating thermomechanical code by combining mechanical solution for 2D buoyancy driven flow with heat diffusion and advection based on marker-in-cell approach.
- Week 11: Subgrid diffusion of temperature. Implementing subgrid diffusion to the thermomechanical code.
- Week 12: Implementation of radioactive, adiabatic and shear heating to the thermomechanical code.
- Week 13: Implementation of temperature-, pressure- and strain rate-dependent viscosity, temperature- and pressure-dependent density and temperature-dependent thermal conductivity to the thermomechanical code. Final project description.

**Lectures notes**

- Script is available by request to taras.gerya@erdw.ethz.ch
- Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS
- Lecture notes: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

**Literature**

- Taras Gerya Introduction to Numerical Geodynamic Modelling. Cambridge University Press, 2010

**GRADING** will be based on homeworks (30%) and oral exams (70%).

**Exam questions:** http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

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**Number**

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<tr>
<td>651-4241-00L</td>
<td>Numerical Modelling I and II: Theory and Applications</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>T. Gerya</td>
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**Autumn Semester 2015**

**6 credits**
Geophysics: Subject 3
Offered in the spring semester

Geophysics: Subject 4
Offered in the spring semester

Geophysics: Subject 5

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<tr>
<td>651-4014-00L</td>
<td>Seismic Tomography</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Kissling, T. Diehl, G. Hetényi</td>
</tr>
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</table>

Abstract
Seismic tomography is the science of interpreting seismic measurements (seismograms) to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it, to gain information about the Earth.

Literature

Geophysics: Subject 6
Offered in the spring semester

Biology

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<tr>
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<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. Stelling</td>
</tr>
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</table>

Abstract
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content
- Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.
- We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Literature

Electives

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<tr>
<th>Number</th>
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<tr>
<td>151-0113-00L</td>
<td>Applied Fluid Dynamics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>J.P. Kusch</td>
</tr>
</tbody>
</table>

Abstract
The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.

Objective
Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.

Content
- Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).
- Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water.
- There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed. The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fires in large installations, as well as when choosing safe transport and storage options for dangerous materials.

Lecture notes
- Prerequisites / notice
- Requirements: successful attendance at lectures “Fluidynamik I und II”, “Thermodynamik I und II”

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<tr>
<td>151-0709-00L</td>
<td>Stochastic Methods for Engineers and Natural Scientists</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>D. W. Meyer-Massetti</td>
</tr>
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</table>

Abstract
The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and subsurface flows. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications.

Objective
By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to use in particular situations.

The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equations that are typical for the FE method. We will consider direct and iterative methods.

The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The ability to independently create a virtual model which describes the complex nonlinear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.


didactical concept:
The course consists of lectures and exercises.

If we will have a large number of students, two dates for the exercises will be offered.

If there are more than 30 students, two dates for the exercises will be offered.

All topics are illustrated with application examples from engineering.

Some textbooks related to the material covered in the course:

3G

Prerequisites:
"Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

Prerequisites:

Didactical concept:
The course consists of lectures and exercises.

The handout is available in German and English.

The handout is available in German and English.

If there are more than 30 students, two dates for the exercises will be offered.
Content

I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.
(2) 1D problems. Piecewise polynomials in 1D.
(3) 2D problems. Triangulations. Piecewise polynomials in 2D.
(4) Variational formulations. Galerkin finite element method.
(5) Implementation aspects.

II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.
(7) Sparse matrices.
(8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.
(10) Preconditioned conjugate gradient method (PCG).
(11) Incomplete factorization preconditioning.
(12) Multigrid preconditioning.
(13) Nonsymmetric problems (GMRES, BiCGstab).
(14) Indefinite problems (SYMMLQ, MINRES).

Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science. The exercises are made with Matlab.

263-5150-00L

Scientific Databases share many aspects with classical DBs, but have additional specific aspects. We will review Relational DBs, Object Oriented DBs, Knowledge DBs, textual DBs and the Semantic Web. All these topics will be studied from the point of view of the scientific applications (Bioinformatics, Physics, Chemistry, Health, Engineering). A toy SDB will be used for exercises.

Abstract

The goals of this course are to:
(a) Familiarize the students with how existing DBs can be used for scientific applications.
(b) Recognize the areas where SciDBs differ and require additional features compared to classical DBs.
(c) Be able to understand more easily SciDBs, improve existing ones or design/create new ones.
(d) Familiarize the students with at least two examples of SciDBs.
One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value.

T. Hofmann

Advanced topics in parallel / concurrent programming.

1) Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area. Hierarchy: File systems, data bases, knowledge bases and variations. Efficiency issues and how they differ from classical DB.

2) Relational DB used for scientific data, pros/cons Introduction to RDB, limitations of the model, basics of SQL, handling of metadata, examples of scientific use of RDBs.

3) Object Oriented DB. Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching. Space and access time efficiency of OODBs.

4) Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.

5) MapReduce / Hadoop

6) Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.


9) An ideal scenario (and the design of a toy system with most of the desired features for exploration and exercises).


12) Performance and space issues, various uses of compression, concurrency control. Hardware issues, clusters, Cloud computing, Crowd-sourcing.

13) Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

Several papers and online articles will be made available. There is no single textbook for this course. A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

263-3010-00L Big Data W 6 credits 3V+1U+1A T. Hofmann

Abstract
One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value. To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the data fast, and applying complex operations to the data.

Objective
To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the data fast, and applying complex operations to the data. This combination of requirements is typically referred to as Big Data and it has led to a completely new way to do business (e.g., develop new products and business models) and do science (sometimes referred to as data-driven science or the "fourth paradigm"). Unfortunately, big data grows faster than our ability to process the data so that new architectures and approaches for processing Big Data are needed.

Content
The goal of this course is to give an overview of Big Data technologies. All aspects are covered: data formats and models, programming languages, optimization techniques, systems, and applications.

Literature
Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

263-2800-00L Design of Parallel and High-Performance Computing W 7 credits 3V+2U+1A T. Hofmann, M. Püschel

Abstract
Advanced topics in parallel / concurrent programming.

Objective
Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

227-0102-00L Discrete Event Systems W 6 credits 4G L. Thiele, L. Vanbever, R. Wattenhofer

Abstract
Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective
Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.
Abstract
Context recognition in mobile communication systems like mobile phone and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning. Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective
Future mobile systems will act as personal and cooperative assistant by providing the appropriate information and services. The systems consist of a smart phone which communicates with sensors on-body and in the environment. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using MatLab the participants implement and verify the discussed methods also using a smart phone.

Content
The next generation of mobile communication systems are integrated in our clothes and act as personal and cooperative assistant providing information we need just now (see www.wearable.ethz.ch). Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include:
- Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, kNN-Methods, Support Vector Machine, Hidden Markov Models, Adaboost), clustering (k-means, dbscan, topic models)
- Crowdsourcing.
- The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.
- Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Language: german/english (depending on the participants)
Lecture notes
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1
Literature
Literature will be announced during the lessons.
Prerequisites / notice
No special prerequisites
The fundamentals of Information Theory including Shannon’s source coding and channel coding theorems

Randomized Algorithms and Probabilistic Methods

The entropy rate of a source, Typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

T.M. Cover and J. Thomas, Elements of Information Theory (second edition)

Signal and Information Processing: Modeling, Filtering, Learning


Course material Script, computer demonstrations, exercises and problem solutions

Lecture notes

Prerequisites / notice

Prerequisites:

Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

The course language is English.

227-0417-00L Information Theory I

W 6 credits 4G A. Lapidoth

Abstract

This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

Objective

The fundamentals of Information Theory including Shannon’s source coding and channel coding theorems

Content

The entropy rate of a source, Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity

Literature

T.M. Cover and J. Thomas, Elements of Information Theory (second edition)

227-0427-00L Signal and Information Processing: Modeling, Filtering, Learning

W 6 credits 4G H.A. Loeliger

Abstract

Fundamentals in signal processing, detection/estimation, and machine learning.

I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparseness.


Objective

The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

Content


Lecture notes

Lecture notes.

227-0627-00L Applied Computer Architecture

W 6 credits 4G A. Gunzinger

Abstract

This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.

Objective

Understand the function, the design and the performance modeling of parallel computer systems.

Content

The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits.

Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?

Which architecture is behind the alarm center of the Swiss Railway (SBB)?

Which computer architectures are applied for driver assistance systems?

Which computer architecture is behind a professional digital audio mixing desk?

Which architecture is behind the alarm center of the Swiss Railway (SBB)?

Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?

Can the weather forecast also be processed with GPUs?

How can a good computer architecture be found?

Which are the driving factors in successful computer architecture design?

Lecture notes

Script and exercises sheets.

Prerequisites / notice

Prerequisites:

- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

252-0417-00L Randomized Algorithms and Probabilistic Methods

W 7 credits 3V+2U+1A A. Steger

Abstract

Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

Objective

After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content

Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes

Yes.


252-0546-00L Physically-Based Simulation in Computer Graphics

W 4 credits 2V+1U B. Solenthaler, B. Thomaszewski

Abstract

This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

Objective

This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.
Mathematical treatment of diverse optimization techniques. The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, handling missing data, and graphical modelling. Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes. The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Lecture notes: We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

401-3627-00L Advanced Topics in Computational Statistics

Abstract: "High-Dimensional Statistics" deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

Objective: Knowledge of methods and basic theory for high-dimensional statistical inference. Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and 1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling.


Prerequisites / notice: Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

401-4623-00L Time Series Analysis

Abstract: Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective: Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content: This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Prerequisites / notice: Not available

401-3901-00L Mathematical Optimization


Objective: 1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas’ Lemma and infeasibility certificates, duality theory of linear programming.


3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.

4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

402-0867-00L Programming Techniques for Scientific Simulations II

Abstract: This course covers advanced general and C++ programming techniques relevant for scientific simulations. The course covers advanced general and C++ programming techniques relevant for scientific simulations. The course will cover, in particular:

* generic algorithm and library design
* exception safety
* smart pointers and safe memory handling
* polymorphism at compile time, at run time and hybrid designs
* mixed language programs, in particular C++, C, Fortran and Python, and the Boost.Python library
* template meta programming and relevant libraries
* C++ libraries for parallel programming on distributed and shared memory machines
* Useful C++ libraries from Boost and other sources

Content: This course covers advanced general and C++ programming techniques relevant for scientific simulations. The course covers advanced general and C++ programming techniques relevant for scientific simulations. The course will cover, in particular:

* generic algorithm and library design
* exception safety
* smart pointers and safe memory handling
* polymorphism at compile time, at run time and hybrid designs
* mixed language programs, in particular C++, C, Fortran and Python, and the Boost.Python library
* template meta programming and relevant libraries
* C++ libraries for parallel programming on distributed and shared memory machines
* Useful C++ libraries from Boost and other sources

402-2203-01L Classical Mechanics

Abstract: A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

401-7855-00L Computational Astrophysics (University of Zurich)

Abstract: No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: AST245

Content: Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html
Objective
Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes.

Content
1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility
2. Large-N gravity calculation, collisionless N-body systems and their simulation
3. Fast Fourier Transform and spectral methods in general
4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters
5. Lagrangian Hydrodynamics: The SPH method
6. Resolution and instabilities in Hydrodynamics
7. Initial Conditions: Cosmological Simulations and Astrophysical Disks
8. Physical Approximations and Methods for Radiative Transfer in Astrophysics

Literature
Galactic Dynamics (Binney & Tremaine, Princeton University Press),
Computer Simulation using Particles (Hockney & Eastwood CRC press),
Targeted journal reviews on computational methods for astrophysical fluids (SPH, AMR, moving mesh)

Prerequisites / notice
Some knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python/ as an example), some prior experience programming, knowledge of C, C++ beneficial.

227-1033-00L
Neuromorphic Engineering I

Objective
Understanding the characteristics of neuromorphic circuit elements.

Content
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconducance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions.

Literature
S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites / notice
Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

227-1037-00L
Introduction to Neuroinformatics

Objective
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Content
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocolures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

327-1201-00L
Transport Phenomena I

Objective
The teaching goals of this course are on five different levels:
1) Deep understanding of fundamentals: local balance equations, constitutive equations for fluxes, entropy balance, interfaces, idea of dimensionless numbers, ...
2) Ability to use the fundamental concepts in applications
3) Insight into the role of boundary conditions
4) Knowledge of a number of applications
5) Flavor of numerical techniques: finite elements, finite differences, lattice Boltzmann, Brownian dynamics, ...

Content
Approach to Transport Phenomena
Diffusion Equation
Brownian Dynamics
Refreshing Topics in Equilibrium Thermodynamics
Balance Equations
Forces and Fluxes
Measuring Transport Coefficients
Pressure-Driven Flows
Heat Exchangers
Complex Fluids

Lecture notes
A detailed manuscript is provided; this manuscript will be developed into a book entitled "A Modern Course in Transport Phenomena" by David C. Venerus and Hans Christian Öttinger.
## Additional Electives from the Fields of Specialization (CSE Master)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4053-05L</td>
<td>Boundary Layer Meteorology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Rotach, P. Calanca</td>
</tr>
<tr>
<td>Abstract</td>
<td>The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.</td>
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<tr>
<td>Objective</td>
<td>Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).</td>
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</tr>
</tbody>
</table>
| Content      | - Introduction  
- Turbulence  
- Statistical treatment of turbulence, turbulent transport  
- Conservation equations in a turbulent flow  
- Closure problem and closure assumptions  
- Scaling and similarity theory  
- Spectral characteristics  
- Concepts for non-ideal boundary layer conditions available (i.e. in English) |
| Lecture notes| available (i.e. in English)                |
| Prerequisites / notice | Umwelt-Fluidynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science |
| 701-1221-00L | Dynamics of Large-Scale Atmospheric Flow   | W    | 4    | 2V+1U | H. Wernli, S. Pfahl    |
| Abstract     | Dynamic, synoptic Meteorology              |
| Objective    | Understanding the dynamics of large-scale atmospheric flow |
| Content      | Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept. |
| Lecture notes| Dynamics of large-scale atmospheric flow   |
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997 |
| 252-0523-00L | Computational Biology                      | W    | 6    | 3V+2U | G. H. Gonnet            |
| Abstract     | Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis. |
| Objective    | Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied. |
| Content      | This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite. |
| 529-0003-00L | Advanced Quantum Chemistry                | W    | 7    | 3G    | M. Reiher, S. Knecht   |
| Abstract     | Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer. Examples are:  
* Operators derived from principles of relativistic quantum mechanics  
* Relativistic effects + methods of relativistic quantum chemistry  
* Open-shell molecules + spin-density functional theory  
* New electron-correlation theories |
The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that the relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum-chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these approximations, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Objective
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Army, 4 credits
W 4 credits 2V+1U  T. Rössgen

Abstract
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Objective
Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization. Understanding of hardware and software requirements and solutions. Development of basic programming skills for (generic) imaging applications.

Content
Fundamentals of optics, flow visualization and electronic image acquisition. Frequently used mage processing techniques (filtering, correlation processing, FFTs, color space transforms). Laser induced fluorescence. (Digital) Schlieren techniques, phase contrast imaging, interferometry, phase unwrapping. Wall shear and heat transfer measurements. Pattern recognition and feature extraction, proper orthogonal decomposition.

Lecture notes
available

Prerequisites / notice
Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

Literature
A) A. Szabo, N. Ostlund, Dover Publications
B) I. N. Levine, Quantum Chemistry, Pearson
G) F. Schwabl: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997
H) R. McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992

Note also the standard textbooks:
A) A. Szabo, N. Ostlund, Dover Publications
B) I. N. Levine, Quantum Chemistry, Pearson
G) F. Schwabl: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997
H) R. McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992

Prerequisites / notice
Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

Literature
**Lecture notes**

**Prerequisites / notice**

**NEW course**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>W Credits</th>
<th>G Credits</th>
<th>Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0213-00L</td>
<td>Fluid Dynamics with the Lattice Boltzmann Method</td>
<td>4</td>
<td>3G</td>
<td>I. Karlin</td>
</tr>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>4</td>
<td>3G</td>
<td>R. D’Andrea</td>
</tr>
<tr>
<td>263-5902-00L</td>
<td>Computer Vision</td>
<td>6</td>
<td>3V+1U+1A</td>
<td>M. Pollefeys, L. Van Gool</td>
</tr>
</tbody>
</table>
Objective
The objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Content
Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice
It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

636-0017-00L Molecular Evolution, Phylogenetics and Phylodynamics

Abstract
The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Objective
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:
* models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics
* stochastic processes
Attendees will apply these concepts to a number of applications yielding biological insight into:
* epidemiology
* pathogen evolution
* macroevolution of species

Content
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes
Slides of the lecture will be available online.

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics.

Case Studies

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3667-65L</td>
<td>Case Studies Seminar (Autumn Semester 2015)</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>V. C. Gradinaru, R. Hiptmair, M. Reiher</td>
</tr>
</tbody>
</table>

Abstract
In the CSE Case Studies Seminar invited speakers from ETH, from other universities as well as from industry give a talk on an applied topic. Beside of attending the scientific talks students are asked to give short presentations (10 minutes) on a published paper out of a list.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATH:

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZEH

Bachelor Thesis

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Target audience:
Third year Bachelor students;
Master students who cannot document to have received an adequate training in working scientifically.

Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later. Optional for Bachelor and Master students with matriculation until or before the spring semester 2014.

Example: You matriculated in the autumn semester 2013 into the first semester of the Bachelor programme, are now in the third year and plan to matriculate in the autumn semester 2016 into the first semester of the Master programme. In this case, you don't need "Scientific Works in Mathematics" in order to complete the Bachelor degree, but for the Master degree you will need it. In this case, we recommend that you register for "Scientific Works in Mathematics" in the autumn semester 2015 or spring semester 2016.

Directive
https://www.ethz.ch/content/dam/ethz/common/docs/weis
Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course “Recherchieren in der Mathematik” (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-3990-01L Bachelor’s Thesis
No direct enrolment to this course unit in myStudies. Please fill in the online application form.
Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html
(Afterwards the enrolment will be done by the Study Administration.)

Abstract
The BSc thesis concludes the curriculum. In their BSc thesis, students should demonstrate their ability to carry out independent, structured scientific work. The purpose of the BSc thesis is to deepen knowledge in a certain subject and to bring students into closer contact with applications in an existing computational group. The BSc thesis requires approximately 160 hours of work.

Objective
In their BSc thesis students should demonstrate their ability to carry out independent, structured scientific work. The purpose is to deepen knowledge in a certain subject and to enable students to collaborate in an existing scientific group to take a computational approach to problems encountered in applications.

Prerequisites / notice
The supervisor responsible for the Bachelor thesis defines the task and determines the start and the submission date. The Bachelor thesis concludes with a written report. The Bachelor thesis is graded.

Colloquia

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

Abstract
Research colloquium

Computational Science and Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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Key for Hours

<table>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W DZ)</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
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<td></td>
<td>The successful participation in EW1 (&quot;Human Learning&quot;) and EW2 (&quot;Designing Learning Environments for School&quot;) is recommended, but not a mandatory prerequisite.</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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<td></td>
<td>In this class, students will learn concepts and skills for coping with psychosocial demands of teaching</td>
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<td></td>
<td>(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).</td>
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<td>(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).</td>
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<td></td>
<td>Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.</td>
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<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects ■ W</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td></td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
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<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td></td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td></td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td>- Getting to know intelligence tests</td>
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<td>- Understanding findings relevant for education</td>
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<td>see Educational Science TC</td>
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### Subject Didactics and Professional Training

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-9908-00L</td>
<td>Teaching Internship Including Examination Lessons ■</td>
<td>W</td>
<td>6</td>
<td>13P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td></td>
<td>Computational Science and Engineering ■</td>
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<td></td>
<td>Teaching Internship Computational Science and Engineering for TC.</td>
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<td></td>
<td>Only for students who enrolled from HS 2011 on into TC.</td>
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<td>The teaching internship can just be visited if all other courses of TC are completed.</td>
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<td></td>
<td>Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.</td>
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</tbody>
</table>
The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

### Content

- The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.
- The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.
- The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.
- They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.
- The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

### Objective

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

### Literature


### Prerequisites

- They learn the skills of the teaching trade.
- They learn to assess pupils' work.
- They learn the skills of the teaching trade.
- They are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.
- They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

### Further Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9902-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus CSE</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>
### 263-2800-00L Design of Parallel and High-Performance Computing

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

**Content**
- Thematical Schwerpunkte:
  - The mentored work in FV is part of the degree in the Literature, a theme over both a Bezug zum gymnasiemal Unterricht or his further development work. The students use in their own individuelles Thema und stellen die eigenständige Arbeit. Sie werden damit von ihrer Betreuungsperson begleitet. Gegebenenfalls stellen sie ihre Arbeit oder Aspekte daraus in einem Kurzvortrag vor. Die mentorierte Arbeit ist Teil des Portfolios der Studierenden.

**Literature**
- Die Literatur ist themenspezifisch. Sie muss je nach Situation des Bezug zum gymnasiemal Unterricht geschafft oder der Verfügung gestellt.

**Prerequisites / notice**
- Die Arbeit sollte vor Beginn Des Projektstarts abgeschlossen werden.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-2800-00L</td>
<td>Design of Parallel and High-Performance Computing</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>T. Hofmann, M. Püschel</td>
</tr>
<tr>
<td>252-0341-01L</td>
<td>Information Retrieval</td>
<td>4</td>
<td>2V+1U</td>
<td>T. Hofmann</td>
</tr>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>6</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
</tr>
<tr>
<td>252-1407-00L</td>
<td>Algorithmic Game Theory</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>P. Widmayer</td>
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</tbody>
</table>

**Objective**
- Students will be familiarised with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

**Content**
- The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

**Topics covered in the lecture include:**
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

**Lecture notes**
- No lecture notes, but slides will be made available on the course webpage.

**Literature**

**Prerequisites / notice**
- Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks

Lecture notes
No lecture notes.

Literature
"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Prerequisites / notice
Several copies of both books are available in the Computer Science library.

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

252-0417-00L Randomized Algorithms and Probabilistic Methods W 7 credits 3V+2U+1A A. Steger

Abstract
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes
Yes.

Literature
Computational Science and Engineering Master

Core Courses (Programme Regulations 2014)

Two core courses out of three must be attended and examinations must be taken in both.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<td>3V+2U</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This course covers some of the fundamental</td>
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<td>concepts of computer graphics, namely 3D</td>
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<td>object representations and generation of</td>
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<td>photorealistic images from digital</td>
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<td>representations of 3D scenes.</td>
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<td>Objective</td>
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<td>At the end of the course the students will</td>
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<td>be able to build a rendering system. The</td>
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<td>students will study the basic principles</td>
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<td>of rendering and image synthesis. In</td>
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<td>addition, the course is intended to</td>
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<td>stimulate the students' curiosity to</td>
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<td>explore the field of computer graphics in</td>
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<td>subsequent courses or on their own.</td>
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<td>Content</td>
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<td>This course covers fundamental concepts of</td>
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<td>modern computer graphics. Students will</td>
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<td>learn about 3D object representations and</td>
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<td>the details of how to generate</td>
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<td>photorealistic images from digital</td>
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<td>representations of 3D scenes. Starting</td>
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<td>with an introduction to 3D shape</td>
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<td>modeling and representation, texture</td>
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<td>mapping and ray-tracing, we will move on</td>
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<td>to acceleration structures, the physics</td>
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<td>of light transport, appearance modeling</td>
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<td>and global illumination principles and</td>
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<td>algorithms. We will end with an overview</td>
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<td>of modern image-based image synthesis</td>
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<td>techniques, covering topics such as</td>
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<td>lightfields and depth-image based</td>
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<td>rendering. The programming assignments</td>
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<td>will be in C++. This will not be taught in</td>
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<td>the class.</td>
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<tr>
<td>Lecture notes</td>
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<td>no</td>
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<tr>
<td>Prerequisites / notice</td>
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<td>Fundamentals of calculus and linear</td>
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<td>Literature</td>
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<td>algebra, basic concepts of algorithms and</td>
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<td>data structures, programming skills in C++,</td>
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<td>Visual Computing course recommended.</td>
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<td>The programming assignments will be in C++.</td>
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<td>This will not be taught in the class.</td>
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Core Courses and Compensatory Courses (Prog. Regl. 2012)

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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0206-00L</td>
<td>Computer Graphics</td>
<td></td>
<td></td>
<td></td>
<td>M. Gross, M. Pollefeys</td>
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<td>4V+3U</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td></td>
<td>This course acquaints students with core</td>
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<td>knowledge in computer graphics, image</td>
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<td>processing, multimedia and computer vision.</td>
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<td></td>
<td>Topics include: Graphics pipeline,</td>
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<td>perception and camera models, transformation,</td>
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<td>shading, global illumination, textureing,</td>
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<td>sampling, filtering, image representations,</td>
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<td>image and video compression, edge detection</td>
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<td>and optical flow.</td>
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<td></td>
<td>Objective</td>
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<td>This course provides an in-depth introduction</td>
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<td>to the core concepts of computer graphics,</td>
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<td>image processing, multimedia and computer</td>
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<td>vision. The course forms a basis for the</td>
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<td>specialization track Visual Computing of the</td>
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<td>CS master program at ETH.</td>
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<td>Content</td>
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<td>Course topics will include: Graphics</td>
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<td>pipeline, perception and color models,</td>
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<td>camera models, transformations and projection,</td>
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<td>projections, lighting, shading, global</td>
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<td>illumination, textureing, sampling theorem,</td>
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<td>Fourier transforms, image representations,</td>
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<td>convolution, linear filtering, diffusion,</td>
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<td>nonlinear filtering, edge detection,</td>
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<td>optical flow, image compression.</td>
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<tr>
<td>Lecture notes</td>
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<td>In theoretical and practical assignment</td>
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<td>Literature</td>
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<td>students will learn to apply and implement</td>
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<td>the presented concepts and algorithms.</td>
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<td>In theoretical and practical assignments</td>
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<td>students will learn to apply and implement</td>
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<td>the presented concepts and algorithms.</td>
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Compensatory Courses

The Director of Studies CSE may specify additional compensatory courses.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<td>252-0535-00L</td>
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<td>Abstract</td>
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<td>Machine learning algorithms provide analytical</td>
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<td>methods to search data sets for</td>
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<td>characteristic patterns. Typical tasks include</td>
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<td>the classification of data, function</td>
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<td>fitting and clustering, with applications in</td>
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<td>image and speech analysis, bioinformatics</td>
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<td>and exploratory data analysis. This course</td>
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<td>is accompanied by practical machine learning</td>
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<td>Students will be familiarized with the most</td>
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<td>important concepts and algorithms for</td>
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<td>supervised and unsupervised learning;</td>
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<td>reinforce the statistics knowledge which is</td>
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<td>indispensable to solve modeling problems</td>
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<td>under uncertainty. Key concepts are the</td>
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<td>generalization ability of algorithms and</td>
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<td>systematic approaches to modeling and</td>
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<td>regularization. A machine learning project</td>
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<td>will provide an opportunity to test the</td>
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<td>machine learning algorithms on real world</td>
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<td>Content</td>
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<td>The theory of fundamental machine learning</td>
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<td>concepts is presented in the lecture,</td>
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<td>and illustrated with relevant applications.</td>
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<td>Students can deepen their understanding by</td>
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<td>solving both pen-and-paper and programming</td>
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<td>exercises, where they implement and apply</td>
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<td>famous algorithms to real-world data.</td>
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<td>Topics covered in the lecture include:</td>
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<td>- Bayesian theory of optimal decisions</td>
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<td>- Maximum likelihood and Bayesian parameter</td>
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<td>inference</td>
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<td>- Classification with discriminant functions:</td>
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<td>Perceptrons, Fisher's LDA and support vector</td>
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<td>machines (SVM)</td>
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<td>- Ensemble methods: Bagging and Boosting</td>
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<td>- Regression: least squares, ridge and</td>
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<td>LASSO penalization, non-linear regression</td>
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<td>and the bias-variance trade-off</td>
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<td>- Non-parametric density estimation: Parzen</td>
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<td>windows, nearest neighbour</td>
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<td>- Dimension reduction: principal component</td>
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<td>analysis (PCA) and beyond</td>
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<td>Lecture notes</td>
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<td>No lecture notes, but slides will be made</td>
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<tr>
<td>Literature</td>
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<td>available on the course webpage.</td>
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<td>C. Bishop. Pattern Recognition and Machine</td>
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<td>R. Duda, P. Hart, and D. Stork. Pattern</td>
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<td>Classification. John Wiley &amp; Sons, second</td>
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<td></td>
<td>T. Hastie, R. Tibshirani, and J. Friedman.</td>
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<td>The Elements of Statistical Learning: Data</td>
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<td>Mining, Inference and Prediction. Springer,</td>
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<td>L. Wasserman, All of Statistics: A Concise</td>
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<td>Course in Statistical Inference. Springer,</td>
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<td>2004.</td>
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Fields of Specialization
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport and dynamics of large-scale atmospheric flow are treated, starting from the basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer. Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere. The students of this course are provided with an introduction into presentation techniques (talks and posters) and practice this knowledge by making an oral presentation about a classical or recent scientific publication.

### Astrophysics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>401-7851-00L</td>
<td>Theoretical Astrophysics (University of Zurich)</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>R. Teyssier</td>
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Mind the enrollment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

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<tbody>
<tr>
<td>651-4053-05L</td>
<td>Boundary Layer Meteorology</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Rotach, P. Calanca</td>
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<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
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### Physics of the Atmosphere

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<th>Number</th>
<th>Title</th>
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<tr>
<td>701-0023-00L</td>
<td>Atmosphere</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>H. Wernli, T. Peter</td>
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</tbody>
</table>

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer. Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

### Chemistry

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0004-00L</td>
<td>Computer Simulation in Chemistry, Biology and Physics</td>
<td>W</td>
<td>7 credits</td>
<td>4G</td>
<td>P. H. Hünlenberger</td>
</tr>
</tbody>
</table>
Abstract
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

Objective
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes
Available (copies of powerpoint slides distributed before each lecture)

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

Prerequisites
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

252-0523-00L Computational Biology W 6 credits 3V+2U G. H. Gonnet

Abstract
Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, structure and function of biomolecules, metabolic processes, sequence similarity, character, parsimony and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

Objective
Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organisms. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

Content
This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

529-0003-00L Advanced Quantum Chemistry W 7 credits 3G M. Reiher, S. Knecht

Abstract
Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer. Examples are:
* Operators derived from principles of relativistic quantum mechanics
* Relativistic effects + methods of relativistic quantum chemistry
* Open-shell molecules + spin-density functional theory
* New electron-correlation theories

Objective
The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

Content
1) Introductory lecture: basics of quantum mechanics and quantum chemistry
2) Einstein’s special theory of relativity and the (classical) electromagnetic interaction of two charged particles
3) Klein-Gordon and Dirac equation; the Dirac hydrogen atom
4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
6) Relativistic effects in chemistry and the emergence of spin
7) Spin in density functional theory
8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
9) Quantum chemistry without the Born-Oppenheimer approximation

Lecture notes
A set of detailed lecture notes will be provided, which will cover the whole course.

Literature
2) F. Schwabl, Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997 [english version available: F. Schwabl, Advanced Quantum Mechanics]
3) R. McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992

Note also the standard textbooks:
A) Szabo, N.S. Ostlund. Verlag, Dover Publications
B) I. N. Levine, Quantum Chemistry, Pearson

401-5940-00L Seminar in Chemistry for CSE W 4 credits 2S P. H. Hünenberger, M. Reiher

Abstract
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes
Available (copies of powerpoint slides distributed before each lecture)

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

Prerequisites
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

252-0523-00L Computational Biology W 6 credits 3V+2U G. H. Gonnet

Abstract
Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, structure and function of biomolecules, metabolic processes, sequence similarity, character, parsimony and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

Objective
Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organisms. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

Content
This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

529-0003-00L Advanced Quantum Chemistry W 7 credits 3G M. Reiher, S. Knecht

Abstract
Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer. Examples are:
* Operators derived from principles of relativistic quantum mechanics
* Relativistic effects + methods of relativistic quantum chemistry
* Open-shell molecules + spin-density functional theory
* New electron-correlation theories

Objective
The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

Content
1) Introductory lecture: basics of quantum mechanics and quantum chemistry
2) Einstein’s special theory of relativity and the (classical) electromagnetic interaction of two charged particles
3) Klein-Gordon and Dirac equation; the Dirac hydrogen atom
4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
6) Relativistic effects in chemistry and the emergence of spin
7) Spin in density functional theory
8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
9) Quantum chemistry without the Born-Oppenheimer approximation

Lecture notes
A set of detailed lecture notes will be provided, which will cover the whole course.

Literature
2) F. Schwabl, Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997 [english version available: F. Schwabl, Advanced Quantum Mechanics]
3) R. McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992

Note also the standard textbooks:
A) Szabo, N.S. Ostlund. Verlag, Dover Publications
B) I. N. Levine, Quantum Chemistry, Pearson

401-5940-00L Seminar in Chemistry for CSE W 4 credits 2S P. H. Hünenberger, M. Reiher
Two-dimensional irrotational (potential) flows: stream function and potential, singularity method, unsteady flow, aerodynamic concepts. Lecture notes are available (in German).

The student will carry out a literature study on a topic of his or her liking or suggested by the supervisor in the area of computer simulation in chemistry, the results of which are to be presented both orally and in written form.

For more information: www.csms.ethz.ch/education/RW

Fluid Dynamics

One of the course units
151-0103-00L Fluid Dynamics II
151-0109-00L Turbulent Flows
is compulsory. Students able to follow courses in German are advised to choose 151-0103-00L Fluid Dynamics II.

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<tr>
<td>151-0103-00L</td>
<td>Fluid Dynamics II</td>
<td>O</td>
<td>3</td>
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<td>P. Jenny</td>
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<td>151-0109-00L</td>
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<td>4</td>
<td>2G+1U</td>
<td>P. Jenny</td>
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<td>W</td>
<td>4</td>
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<td>P. Jenny</td>
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Lecture notes
Lecture notes are available (in German).

Literature
Relevant chapters (corresponding to lecture notes) from the textbook


Prerequisites / notice
Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

Fundamentals of CFD Methods

This course is focused on providing students with the knowledge and understanding required to develop simple computational fluid dynamics (CFD) codes to solve the incompressible Navier-Stokes equations and to critically assess the results produced by CFD codes. As part of the course, students will write their own codes and verify and validate them systematically.

Objective
1. Students know and understand basic numerical methods used in CFD in terms of accuracy and stability.
2. Students have a basic understanding of a typical simple CFD code.
3. Students understand how to assess the numerical and physical accuracy of CFD results.

Content
1. Governing and model equations. Brief review of equations and properties
2. Overview of basic concepts: Overview of discretization process and its consequences
3. Overview of numerical methods: Finite-difference and finite-volume methods
4. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
5. Time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
6. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
7. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov's theorem, TVD methods, DRP methods
8. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
9. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
10. Solution of one-dimensional advection-diffusion equation: Numerical vs physical viscosity, boundary layers, non-uniform grids
11. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, fractional-step and pressure-correction methods
12. Solution of incompressible Navier-Stokes equations on unstructured grids

Lecture notes
The course is based mostly on notes developed by the instructor.

Literature
There is no required textbook. Suggested references are:

Quantitative Flow Visualization

The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.
The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas.

Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   Particle's distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation; Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.

5. Microflow:
   Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   Relativistic fluid dynamics; flows with phase transitions. Lecture notes on the theoretical parts of the course will be made available. Selected original and review papers are provided for some of the lectures on advanced topics. Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

**Objective**

Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization.

Understanding of hardware and software requirements and solutions.

Development of basic programming skills for (generic) imaging applications.

**Content**

Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

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Systems and Control

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<tr>
<td>227-0103-00L</td>
<td>Control Systems</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>M. Morari, F. Dörfler</td>
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<tr>
<td>Abstract</td>
<td>Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.</td>
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<tr>
<td>Lecture notes</td>
<td>Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF).</td>
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<td>Prerequisites: Signal and Systems Theory II.</td>
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<td>227-0045-00L</td>
<td>Signals and Systems I</td>
<td>W</td>
<td>4</td>
<td>2V+2U</td>
<td>H. Bölcskei</td>
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<tr>
<td>Objective</td>
<td>Introduction to mathematical signal processing and system theory.</td>
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<td>Lecture notes, problem set with solutions.</td>
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<td>227-0225-00L</td>
<td>Linear System Theory</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>J. Lygeros, M. Kamgarpour</td>
</tr>
<tr>
<td>Abstract</td>
<td>The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from aeronautics to systems biology.</td>
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<tr>
<td>Objective</td>
<td>By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.</td>
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<td>Prerequisites / notice</td>
<td>Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.</td>
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<td>151-0575-01L</td>
<td>Signals and Systems</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>R. D’Andrea</td>
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<tr>
<td>Abstract</td>
<td>Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.</td>
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<td>Objective</td>
<td>Master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercises.</td>
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<td>Lecture notes</td>
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<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>R. D’Andrea</td>
</tr>
<tr>
<td>Objective</td>
<td>Content</td>
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<tr>
<td>401-5850-00L</td>
<td>Seminar in Systems and Control for CSE</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>J. Lygeros</td>
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Robotics

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<tr>
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<tr>
<td>151-0601-00L</td>
<td>Theory of Robotics and Mechatronics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Korba, S. Stoeter, B. Nelson</td>
</tr>
</tbody>
</table>

Abstract
This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Objective
Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Content
An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

Lecture notes
The course will be taught in English.

252-0535-00L Machine Learning W 6 credits 3V+2U J. M. Buhmann
Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature


Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

263-5902-00L Computer Vision W 6 credits 3V+1U+1A M. Pollefeys, L. Van Gool
Abstract
The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

Objective
The objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Content
Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice
It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

151-0563-01L Dynamic Programming and Optimal Control W 4 credits 3G R. D'Andrea
Abstract
Introduction to Dynamic Programming and Optimal Control.

Objective
Covers the fundamental concepts of Dynamic Programming & Optimal Control.

Content
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

Literature

Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

151-0851-00L Robot Dynamics W 4 credits 2V+1U R. Siegwart, M. Hutter, K. Rudin, T. Staab
Abstract
We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

Objective
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.
### Computational Finance

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3913-01L</td>
<td>Mathematical Foundations for Finance</td>
<td>W</td>
<td>4</td>
<td>3+2U</td>
<td>E. W. Farkas, M. Schweizer</td>
</tr>
</tbody>
</table>

**Abstract**

This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

**Content**

- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô’s formula, Girsanov transformation, Itô’s representation theorem
- Black-Scholes formula

**Prerequisites / notice**

Lecture notes will be sold at the beginning of the course.

### Numerical Analysis of Stochastic Ordinary Differential Equations

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-4657-00L</td>
<td>Numerical Analysis of Stochastic Ordinary Differential Equations</td>
<td>W</td>
<td>6</td>
<td>3+1U</td>
<td>A. Jentzen</td>
</tr>
</tbody>
</table>

**Abstract**

This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and supercomputers. The course will cover topics such as simulations, percolation, phase transitions, Electrodynamics and statistical mechanics as well as interdisciplinarity with Fluid Dynamics.

**Objective**

The students are familiar with the challenges of the fascinating and interdisciplinary field of Physics and Mechatronics. They are introduced to the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

**Content**

This 4 ECTS course offers a comprehensive overview of simulation methods and their applications in various fields of physics. The course will cover topics such as classical and quantum mechanics, statistical mechanics, and numerical methods. Students will be introduced to computer simulation techniques and programming methods for numerical simulations (primarily in C++) and learn about the basics of object-oriented programming.

**Prerequisites / notice**

Lecture notes and exercise lessons in English, exams in German or in English.
Abstract
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content
Generation of random numbers
Monte Carlo methods for the numerical integration of random variables
Stochastic processes and Brownian motion
Stochastic ordinary differential equations (SODEs)
Numerical approximations of SODEs
Multilevel Monte Carlo methods for SODEs
Applications to computational finance: Option valuation

Lecture notes
Lecture Notes will be available.

Literature

Prerequisites / notice
Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.

401-8905-00L Financial Engineering (University of Zurich) W 4.5 credits 3G University lecturers

401-5820-00L Seminar in Computational Finance for CSE W 4 credits 2S D. Würtz

401-2037-00L Physical Modelling and Simulation W 5 credits 4G C. Hafner, J. Leuthold, J. Smajic

Electromagnetics

Objective

Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained.

Content

Since the fabrication and characterization of micro- and nanostructures is difficult, expensive, and time-consuming, numerical modelling drastically reduced the design process. Although many commercial software packages are available, it is important to know the drawbacks and difficulties of the numerical methods behind them and to be able to validate the results obtained with such packages.

First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the problems to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electrodynamics to multiphysics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

227-0707-00L Optimization Methods for Engineers W 3 credits C. Hafner, P. Leuchtmann

Abstract

First half of the semester: Introduction to the main methods of numerical optimization with focus on stochastic methods such as genetic algorithms, evolutionary strategies, etc.

Second half of the semester: Each participant implements a selected optimizer and applies it on a problem of practical interest.

Objective

Numerical optimization is of increasing importance for the development of devices and for the design of numerical methods. The students shall learn to select, improve, and combine appropriate procedures for efficiently solving practical problems.

Content

Typical optimization problems and their difficulties are outlined. Well-known deterministic search strategies, combinatorial minimization, and evolutionary algorithms are presented and compared. In engineering, optimization problems are often very complex. Therefore, new techniques based on the generalization and combination of known methods are discussed. To illustrate the procedure, various problems of practical interest are presented and solved with different optimization codes.

Lecture notes

PDF file see http://alphard.ethz.ch/hafner/Vorles/lect.htm

Prerequisites / notice

Lecture in the first half of the semester, exercises in form of small projects in the second half, presentation of the results in the last week of the semester.

227-0301-00L Optical Communication Fundamentals W 6 credits 2V+1U+1P J. Leuthold

Abstract

The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system. This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements.

Objective

An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the ongoing exponential growth in the field of communications.

Content

* Chapter 1: Introduction: Analog/Digital conversion, The communication channel, Shannon channel capacity, Capacity requirements.


* Chapter 4: The Receiver: Photodiodes, Receiver noise, Detector schemes (direct detection, coherent detection), Bit-error ratios and error estimations.

* Chapter 5: Digital Signal Processing Techniques: Digital signal processing in a coherent receiver, Error detection techniques, Error correction coding.

* Chapter 6: Pulse Shaping and Multiplexing Techniques: WDM/FDM, TDM, OFDM, Nyquist Multiplexing, OCDMA.

* Chapter 7: Optical Amplifiers: Semiconductor Optical Amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers.

Lecture notes

Lecture notes are handed out.

Literature

Govind P. Agrawal; "Fiber-Optic Communication Systems"; Wiley, 2010

Prerequisites / notice


401-5870-00L Seminar in Electromagnetics for CSE W 4 credits 2S C. Hafner, J. Leuthold

Abstract

Various topics of electromagnetics, including electromagnetic theory, computational electromagnetics, electromagnetic wave propagation, applications from statics to optics. Traditional problems such as antennas, electromagnetic scattering, waveguides, resonators, etc. as well as modern topics such as photonic crystals, metamaterials, plasmonics, etc. are considered.

Objective

Knowledge of the fundamentals of electromagnetic theory, development and application of numerical methods for solving Maxwell equations, analysis and optimal design of electromagnetic structures.

Geophysics

Recommended combinations:

Subject 1 + Subject 2
Subject 1 + Subject 3
Subject 2 + Subject 3
Subject 2 + Subject 4
Subject 5 + Subject 6
Subject 5 + Subject 4

Geophysics: Subject 1

Number Title Type ECTS Hours Lecturers

651-4007-00L Continuum Mechanics W 3 credits 2V T. Gerya

Abstract

In this course, students learn crucial partial differential equations (conservation laws) that are applicable to any continuum including the Earth's mantle, core, atmosphere and ocean. The course will provide step-by-step introduction into the mathematical structure, physical meaning and analytical solutions of the equations. The course has a particular focus on solid Earth applications.

Objective

The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth's mantle, core, atmosphere and ocean. By the end of the course, students should be able to write, explain and analyse the equations and apply them for simple analytical cases. Numerical solving of these equations will be discussed in the Numerical Modelling I and II course running in parallel.
A provisional week-by-week schedule (subject to change) is as follows:

Week 1: The continuity equation
Theory: Definition of a geological media as a continuum. Field variables used for the representation of a continuum. Methods for definition of the field variables. Eulerian and Lagrangian points of view. Continuity equation in Eulerian and Lagrangian forms and their derivation.
Exercise: Programming to solve the continuity equation. Solutions using finite difference methods. Implementing numerical solutions in MATLAB.

Week 2: Density and gravity
Theory: Density of rocks and minerals. Thermal expansion and compressibility. Dependence of density on temperature and pressure.
Equations of state. Poisson equation for gravitational potential and its derivation.
Exercise: Computing density, thermal expansion and compressibility from an equation of state.

Week 3: Stress and strain
Exercise: Analyzing strain rate tensor for solid body rotation.

Week 4: The momentum equation
Stokes equation of slow laminar flow of highly viscous incompressible fluid and its application to geodynamics. Simplification of the Stokes equation in case of constant viscosity and its relation to the Poisson equation.
Exercise: Computing velocity for magma flow in a channel.

Week 5: Viscous rheology of rocks
Theory: Solid-state creep of minerals and rocks as the major mechanism of deformation of the Earth's interior. Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws.
Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

Week 6: The heat conservation equation
Heat conservation equation for the case of a constant thermal conductivity and its relation to the Poisson equation.
Exercise: Steady temperature profile in case of channel flow.

Week 7: Elasticity and plasticity

GRADING will be based on homeworks (30%) and oral exams (70%).

Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

GRADING will be based on homeworks (50%) and a term project (50%) to develop an application of their choice to a more advanced level.
Seismic tomography is the science of interpreting seismic measurements (seismograms) to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it, to gain information about the Earth.

Literature

Computational Systems Biology

Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content
Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Literature

Molecular Evolution, Phylogenetics and Phyloinformatics

The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phyloinformatics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Objective
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:
- models in molecular evolution
- phylogenetic & phyloinformatic inference
- maximum likelihood and Bayesian statistics
- stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:
- epidemiology
- pathogen evolution
- macroevolution of species

Content
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phyloinformatics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes
Slides of the lecture will be available online.
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

**Prerequisites / notice**
- Basic knowledge in linear algebra, analysis, and statistics.

### Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>151-0113-00L</td>
<td>Applied Fluid Dynamics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>J.P. Kunsch</td>
</tr>
<tr>
<td>Abstract</td>
<td>Applied Fluid Dynamics</td>
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<tr>
<td>Content</td>
<td>The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment. Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.). Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples. Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water. There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed. The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fireballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.).</td>
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**Lecture notes**
- not available

**Prerequisites / notice**
- Requirements: successful attendance at lectures "Fluidodynamik I und II", "Thermodynamik I und II"

<table>
<thead>
<tr>
<th>151-0709-00L</th>
<th>Stochastic Methods for Engineers and Natural Scientists</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>D. W. Meyer-Massetti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and subsurface flows. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications. By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.</td>
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<tr>
<td>Content</td>
<td>By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems. - Probability theory, single and multiple random variables, mappings of random variables - Stochastic differential equations, Ito calculus, PDF evolution equations - Polynomial chaos and other expansion methods</td>
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**Lecture notes**
- Detailed lecture notes will be provided.

**Literature**
- Some textbooks related to the material covered in the course:

<table>
<thead>
<tr>
<th>151-0317-00L</th>
<th>Visualization, Simulation and Interaction - Virtual Reality II</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>A. Kunz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes. Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.</td>
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<tr>
<td>Content</td>
<td>Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.</td>
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**Lecture notes**
- The handout is available in German and English.

**Prerequisites / notice**
- Prerequisites: "Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

- Didactical concept: The course consists of lectures and exercises.

<table>
<thead>
<tr>
<th>151-0833-00L</th>
<th>Principles of Nonlinear Finite-Element-Methods</th>
<th>W</th>
<th>5 credits</th>
<th>2V+2U</th>
<th>N. Manopulo, B. Berisha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.</td>
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<tr>
<td>Objective</td>
<td>The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:</td>
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</table>

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

**Objective**

Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.

**Content**

I. **THE FINITE ELEMENT METHOD**

1. Introduction, model problems.
2. 1D problems. Piecewise polynomials in 1D.
3. 2D problems. Triangulations. Piecewise polynomials in 2D.
5. Implementation aspects.

II. **DIRECT SOLUTION METHODS**

6. LU and Cholesky decomposition.
7. Sparse matrices.

III. **ITERATIVE SOLUTION METHODS**

9. Stationary iterative methods, preconditioning.
11. Incomplete factorization preconditioning.
12. Multigrid preconditioning.
13. Nonsymmetric problems (GMRES, BiCGstab).

**Literature**


**Prerequisites / notice**

Prerequisites: Linear Algebra, Analysis, Computational Science. The exercises are made with Matlab.
One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value.

Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

Advanced topics in parallel / concurrent programming.

Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the

The goal of this course is to give an overview of Big Data technologies. All aspects are covered: data formats and models, programming

3V+1U+1A

M. Püschel

L. Thiele

W

1)  - Introduction, Statement of the problem, course structure, exercises,
why Scientific DBs (SDBs) do not fit exactly the classical DB area.
Hierarchy: File systems, data bases, knowledge bases and variations.
Efficiency issues and how they differ from classical DB.

2)  - Relational DB used for scientific data, pros/cons
Introduction to RDB, limitations of the model, basics of SQL,
handling of metadata, examples of scientific use of RDBs.

3)  - Object Oriented DB. Rich/structured objects are very appealing
in SDB. OODB primitives and environments. OODB searching,
Space and access time efficiency of OODBs.

4)  - Knowledge bases, key-value stores, ontologies, workflow-based
architectures. WASA.

5)  - MapReduce / Hadoop

6)  - Storing and sharing mathematical objects, Open Math, its relation
with OODB and Knowledge bases. Also the problem of chemical
formula representation.

7)  - SGML and XML, human-readable databases, genomic databases.
Advantages of human-readable databases (the huge initial success
of genomic databases).

8)  - Semantic web, Resource Description Framework (RDF) triples, SparQL.
An example of very flexible database for knowledge storage. Goals of
the Semantic Web, discussion about its future.

9)  - An ideal scenario (and the design of a toy system with most of the
desired features for exploration and exercises).

10)  - Automatic dependency management, (make and similar). The graph

11)  - Functional testing, Verifiers, Consistency, Short-circuit testing,
Recovery and Automatic recovery, Backup (incremental) methods.

12)  - Performance and space issues, various uses of compression,
concurrency control. Hardware issues, clusters, Cloud computing,
Crowd-sourcing.

13)  - Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

Several papers and online articles will be made available.

There is no single textbook for this course.

The goal of this course is to give an overview of Big Data technologies. All aspects are covered: data formats and models, programming
languages, optimization techniques, systems, and applications.

Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

Big Data

W 6 credits 3V+1U+1A T. Hofmann

One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value.

To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the
data fast, and applying complex operations to the data.

Objective

One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value.

To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the
data fast, and applying complex operations to the data. This combination of requirements is typically referred to as Big Data and it has led
to a completely new way to do business (e.g., develop new products and business models) and do science (sometimes referred to as data-
driven science or the "fourth paradigm"). Unfortunately, big data grows faster than our ability to process the data so that new architectures
and approaches for processing Big Data are needed.

Content

The goal of this course is to give an overview of Big Data technologies. All aspects are covered: data formats and models, programming
languages, optimization techniques, systems, and applications.

Objectives:

1) Introduction, Statement of the problem, course structure, exercises,
why Scientific DBs (SDBs) do not fit exactly the classical DB area.
Hierarchy: File systems, data bases, knowledge bases and variations.
Efficiency issues and how they differ from classical DB.

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Space and access time efficiency of OODBs.

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Advantages of human-readable databases (the huge initial success
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An example of very flexible database for knowledge storage. Goals of
the Semantic Web, discussion about its future.

9) An ideal scenario (and the design of a toy system with most of the
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10) Automatic dependency management, (make and similar). The graph

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The goal of this course is to give an overview of Big Data technologies. All aspects are covered: data formats and models, programming
languages, optimization techniques, systems, and applications.

Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

Design of Parallel and High-Performance Computing

W 7 credits 3V+2U+1A T. Hofelker, M. Püschel

Advanced topics in parallel / concurrent programming.

Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing
possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become
familiar with important technical concepts and with concurrency folklore.

Discrete Event Systems

W 6 credits 4G L. Thiele, L. Vanbever, R. Wattenhofer

Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course
we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages,

Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the
proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans.
The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a
keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study
processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new
modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event
systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete
event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and
queueing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems
from a worst-case perspective using the theory of online algorithms and adversarial queuing.
Context

1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes
Available

Literature
[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune.

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser.

227-0197-00L Wearable Systems I

Abstract
Context recognition in mobile communication systems like mobile phone and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning. Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective
Future mobile systems will act as personal and cooperative assistant by providing the appropriate information and services. The systems consist of a smart phone which communicates with sensors on-body and in the environment. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using MatLab the participants implement and verify the discussed methods also using a smart phone.

Content
The next generation of mobile communication systems are integrated in our clothes and act as personal and cooperative assistant providing information we need just now (see www.wearable.ethz.ch). Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include
- Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, kNN-Methods, Support Vector Machine, Hidden Markov Models, Adaboost), clustering (k-means, dbscan, topic models)
- Crowdsourcing.
- The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.
- Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Language: german/english (depending on the participants)

Lecture notes
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1

Literature
Literature will be announced during the lessons.

Prerequisites / notice
No special prerequisites
Content

The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that can be handed over to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information about multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes

Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice

Prerequisites:

Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

Course language: English.

227-0417-00L Information Theory I

Abstract

This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

Objective

The fundamentals of Information Theory including Shannon's source coding and channel coding theorems.

Content

The entropy rate of a source. Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity

Literature

T.M. Cover and J. Thomas, Elements of Information Theory (second edition)

227-0427-00L Signal and Information Processing: Modeling, Filtering, Learning

Abstract

Fundamentals in signal processing, detection/estimation, and machine learning.


Objective

The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

Content


227-0627-00L Applied Computer Architecture

Abstract

This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.

Objective

Understand the function, the design and the performance modeling of parallel computer systems.

Content

The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits.

Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?

Which architecture is behind the alarm center of the Swiss Railway (SBB)?

Which computer architectures are applied for driver assistance systems?

Which computer architecture is hidden behind a professional digital audio mixing desk?

How can data volumes about 30 TB/s, produced by a proton accelerator, be processed in real time?

Can the weather forecast also be processed with GPUs?

How can a good computer architecture be found?

Which are the driving factors in successful computer architecture design?

252-0237-00L Concepts of Object-Oriented Programming

Abstract

Course focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection

Objective

After this course, students will:

Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features.

Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs.

Be able to learn new languages more rapidly.

Be aware of many subtle problems of object-oriented programming and know how to avoid them.

Content

The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.

The topics discussed in the course include among others:

The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing)

The key problems of single and multiple inheritance and how different languages address them.

Generic type systems, in particular. Java generics, C# generics, and C++ templates

The situations in which object-oriented programming does not provide encapsulation, and how to avoid them.

The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing.

How to maintain the consistency of data structures

Literature

Will be announced in the lecture.
**Prerequisites**
Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming); programming experience

**Course Information**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Module Code</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>252-0417-00L</td>
<td>Randomized Algorithms and Probabilistic Methods</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>A. Steger</td>
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<tr>
<td>Abstract</td>
<td>Las Vegas &amp; Monte Carlo algorithms; inequalities of Markov, Chebyshev,</td>
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<td>Chernoff; negative correlation; Markov chains: convergence,</td>
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<td>rapidly mixing; generating functions; Examples include: min cut,</td>
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<td>median, balls and bins, routing in hypercubes, 3SAT, card</td>
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<td>shuffling, random walks</td>
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<td>Objective</td>
<td>After this course students will know fundamental techniques from</td>
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<td>probabilistic combinatorics for designing randomized algorithms and</td>
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<td>will be able to apply them to solve typical problems in these</td>
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<td>areas.</td>
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<tr>
<td>Content</td>
<td>Randomized Algorithms are algorithms that &quot;flip coins&quot; to take</td>
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<td>certain decisions. This concept extends the classical model of</td>
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<td>deterministic algorithms and has become very popular and useful</td>
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<td>within the last twenty years. In many cases, randomized algorithms</td>
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<td>are faster, simpler or just more elegant than deterministic ones.</td>
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<td>In the course, we will discuss basic principles and techniques and</td>
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<td>derive from them a number of randomized methods for problems in</td>
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<td>different areas.</td>
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<td>Literature</td>
<td>Yes.</td>
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<td></td>
<td>- Randomized Algorithms, Rajeev Motwani and Prabhakar Raghavan,</td>
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<td></td>
<td>- Probability and Computing, Michael Mitzenmacher and Eli Upfal,</td>
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<td>Cambridge University Press (2005)</td>
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<tr>
<td>252-0527-00L</td>
<td>Probabilistic Graphical Models for Image Analysis</td>
<td>4</td>
<td>3G</td>
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<tr>
<td>Abstract</td>
<td>This course will focus on the algorithms for inference and learning</td>
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<td>with statistical models. We use a framework called probabilistic</td>
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<td>graphical models which include Bayesian Networks and Markov Random</td>
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<td>Fields.</td>
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<td>Objective</td>
<td>Students will be introduced to probabilistic graphical models and</td>
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<td>will learn how to apply them to problems in image analysis and</td>
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<td>understanding. The focus will be to study various algorithms for</td>
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<td>inference and parameter learning.</td>
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<td>Literature</td>
<td>Will be announced during the lecture.</td>
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<td>252-0546-00L</td>
<td>Physically-Based Simulation in Computer Graphics</td>
<td>4</td>
<td>2V+1U</td>
<td>B. Solenthaler, B. Thomaszewski</td>
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<tr>
<td>Abstract</td>
<td>This lecture provides an introduction to physically-based animation</td>
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<td>in computer graphics and gives an overview of fundamental methods</td>
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<td>and algorithms. The practical exercises include three assignments</td>
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<td>which are to be solved in small groups. In an additional course</td>
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<td>project, topics from the lecture will be implemented into a 3D game</td>
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<td>or a comparable application.</td>
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<td>Objective</td>
<td>This lecture provides an introduction to physically-based analysis</td>
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<td>in computer graphics and gives an overview of fundamental methods</td>
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<td>and algorithms. The practical exercises include three assignments</td>
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<td>which are to be solved in small groups. In an additional course</td>
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<td>project, topics from the lecture will be implemented into a 3D game</td>
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<td>or a comparable application.</td>
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<tr>
<td>Content</td>
<td>The lecture covers topics in physically-based modeling,</td>
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<td>such as particle systems, mass-spring models, finite difference and</td>
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<td>finite element methods. These approaches are used to represent and</td>
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<td>simulate deformable objects or fluids with applications in animated</td>
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<td>movies, 3D games and medical systems. Furthermore, the lecture</td>
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<td>covers topics such as rigid body dynamics, collision detection, and</td>
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<td>character animation.</td>
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<td>Prerequisites / notice</td>
<td>Fundamentals of calculus and physics, basic concepts of algorithms and data structures, basic programming skills in C++. Knowledge on numerical mathematics as well as ordinary and partial differential equations is an asset, but not required.</td>
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<td>401-4655-64L</td>
<td>Numerical Analysis of High-Dimensional Problems for</td>
<td>6</td>
<td>3G</td>
<td>C. Schwab</td>
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<tr>
<td>Abstract</td>
<td>In many applications of mathematics, efficient numerical methods for</td>
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<td>PDEs on high dimensional state and/or parameter spaces is required.</td>
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<td>This course provides succinct surveys of recently developed numerical</td>
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<td>methods, their computer implementation for model problems, and</td>
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<td>elements of their mathematical analysis for the efficient</td>
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<td>approximation of high- and infinite-dimensional PDE problems.</td>
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<td>Content</td>
<td>[not necessarily in order of appearance]</td>
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<td></td>
<td>1. Infinite-Dimensional Analysis</td>
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<td>Probability spaces and measures,</td>
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<td>Tensor Products,</td>
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<td>Measures on function spaces,</td>
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<td>Covariance operators,</td>
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<td>PCA and KL-expansions, (generalized) polynomial chaos expansions,</td>
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<td>Kolmogoroff N-widths</td>
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<td>2. Examples.</td>
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<td>Parametric Approximation Problems.</td>
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<td>Parametric ODEs (biochemical reaction pathways).</td>
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<td>Parametric PDEs (diffusion problems with random coefficients).</td>
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<td>PDEs in Parametric Domains (Scattering from random obstacles).</td>
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<td>3. Stochastic Galerkin Methods</td>
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<td>4. Stochastic Collocation Methods</td>
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<td>Smolyak's algorithm and its generalizations; sparse, adaptive</td>
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<td>interpolation algorithms</td>
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<td>6. Reduced Basis Methods</td>
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<td>7. Monte Carlo Methods</td>
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<td>8. Quasi-Monte Carlo Methods</td>
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<td>Bayesian Inverse Problems</td>
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<td>Shape Sensitivity Analysis of PDEs</td>
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<td>Optimal Control of parametric ODEs and PDEs.</td>
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<td></td>
<td>Optimization of Parametric ODEs and PDEs.</td>
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</table>

Literature

Books and Surveys:


Prerequisites / notice

ETH BSc Math or equivalent

and

Num. elliptic and Parabolic PDE
or
Num. hyperbolic PDE
or

ETH Doctoral Studies in applied mathematics or CSE.

Programming:
MATLAB (for MSc MATH)
or
Python and C/C++/MPI programming (MSc CSE).

401-3611-00L Advanced Topics in Computational Statistics
W 4 credits 2V
M. H. Maathuis, M. Mächler

Abstract
This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

Objective
Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

Content
The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Lecture notes
Lecture notes.

Prerequisites / notice
We assume a solid background in mathematics, an introductory lecture in probability and statistics.

401-3627-00L High-Dimensional Statistics
W 4 credits 2V
P. L. Bühlmann

Abstract
"High-Dimensional Statistics" deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

Objective
Knowledge of methods and basic theory for high-dimensional statistical inference

Content
Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

Literature

Prerequisites / notice
Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

401-4623-00L Time Series Analysis
W 6 credits 3G
not available

Abstract
Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective
Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content
This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, linear and generalized linear models. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Lecture notes
Not available

Literature
A list of references will be distributed during the course.

Basic knowledge in probability and statistics

401-3901-00L Mathematical Optimization
W 11 credits 4V+2U
R. Weismantel

Abstract
Mathematical treatment of diverse optimization techniques.

Objective
Advanced optimization theory and algorithms.
Content
1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.
3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.
4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

402-0867-00L Programming Techniques for Scientific Simulations II
W 6 credits 3G M. Troyer

Abstract
This course covers advanced general and C++ programming techniques relevant for scientific simulations.

Content
This course covers advanced general and C++ programming techniques relevant for scientific simulations. The course will cover, in particular:

- generic algorithm and library design
- exception safety
- smart pointers and safe memory handling
- polymorphism at compile time, at run time and hybrid designs
- mixed language programs, in particular C++, C, Fortran and Python, and the Boost,Python library
- template meta programming and relevant libraries
- C++ libraries for parallel programming on distributed and shared memory machines
- Useful C++ libraries from Boost and other sources

402-0777-00L Particle Accelerator Physics and Modeling I
W 6 credits 2V+1U A. Adelmann

Abstract
This is the first of two courses, introducing particle accelerators from a theoretical point of view and covers state-of-the-art modeling techniques. It emphasizes the multidisciplinary aspect of the field, both in methodology (numerical and computational methods) and with regard to applications such as medical, industrial, material research and particle physics.

Objective
You understand the building blocks of particle accelerators. Modern analysis tools allows you to model state-of-the-art particle accelerators. In some of the exercises you will be confronted with next generation machines. We will develop a Python simulation tool (AcceLEGOrator) that reflects the theory from the lecture.

Content
Here is the rough plan of the topics, however the actual pace may vary relative to this plan.

- Particle Accelerators an Overview
- Relativity for Accelerator Physicists
- Building Blocks of Particle Accelerators
- Lie Algebraic Structure of Classical Mechanics and Applications to Particle Accelerators
- Symplectic Maps & Analysis of Maps
- Particle Tracking
- Linear & Circular Machines
- Cyclotrons
- Free Electron Lasers
- Collective effects in linear approach
- Preview of Particle Accelerator Physics and Modeling II

Literature
Particle Accelerator Physics, H. Wiedemann, ISBN-13 978-3-540-49043-2, Springer


Prerequisites
Physics, Computational Science (RW) at BSc. Level

This lecture is also suited for PhD. students

401-7855-00L Computational Astrophysics (University of Zurich)
W 6 credits 2V L. M. Mayer

Objective
Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes

Content
1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility
2. Large-N gravity calculation, collisionless N-body systems and their simulation
3. Fast Fourier Transform and spectral methods in general
4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters
5. Lagrangian Hydrodynamics: The SPH method
6. Resolution and instabilities in Hydrodynamics
7. Initial Conditions: Cosmological Simulations and Astrophysical Disks
8. Physical Approximations and Methods for Radiative Transfer in Astrophysics

Literature
Galactic Dynamics (Binney & Tremaine, Princeton University Press),
Computer Simulation using Particles (Hockney & Eastwood CRC press),
Targeted journal reviews on computational methods for astrophysical fluids (SPH, AMR, moving mesh)

Prerequisites
Some knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python/ as an example), some prior experience programming, knowledge of C, C++ beneficial

227-1033-00L Neuromorphic Engineering I
W 6 credits 2V+3U T. Delbrück, G. Indiveri, S.C. Liu

Abstract
This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective
Understanding of the characteristics of neuromorphic circuit elements.
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, conductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

**227-1037-00L**

**Introduction to Neuroinformatics**

A detailed manuscript is provided; this manuscript will be developed into a book entitled "A Modern Course in Transport Phenomena" by David C. Venerus and Hans Christian Öttinger. The teaching goals of this course are on five different levels:

1. **Phenomenological approach to "Transport Phenomena"** based on balance equations supplemented by thermodynamic considerations to formulate the undetermined fluxes in the local species mass, momentum, and energy balance equations; fundamentals, applications, and simulations

2. **Approach to Transport Phenomena**
   - Diffusion Equation
   - Brownian Dynamics
   - Refreshing Topics in Equilibrium Thermodynamics
   - Balance Equations
   - Forces and Fluxes
   - Measuring Transport Coefficients
   - Pressure-Driven Flows
   - Heat Exchangers
   - Complex Fluids

3. **Fundamentals of Probability, Fundamentals of Computational Modeling**

4. **Computational Methods**
   - (5) Flavor of numerical techniques: finite elements, finite differences, lattice Boltzmann, Brownian dynamics, ...
   - (4) Knowledge of a number of applications
   - (3) Insight into the role of boundary conditions
   - (2) Use of the fundamental concepts in applications
   - (1) Deep understanding of fundamentals: local balance equations, constitutive equations for fluxes, entropy balance, interfaces, idea of dimensionless numbers, ...

5. **Quantitative analysis**
   - Number of participants limited to 60.
   - Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

6. **Data Analysis: A Bayesian Tutorial** by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.
Prerequisites


see also Fields of Specialization

► Case Studies

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3667-65L</td>
<td>Case Studies Seminar (Autumn Semester 2015)</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>V. C. Gradianu, R. Hiptmair, M. Reiher</td>
</tr>
</tbody>
</table>

Abstract
In the CSE Case Studies Seminar invited speakers from ETH, from other universities as well as from industry give a talk on an applied topic. Beside of attending the scientific talks students are asked to give short presentations (10 minutes) on a published paper out of a list.

► Semester Paper

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

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<th>Number</th>
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<tbody>
<tr>
<td>401-3740-01L</td>
<td>Semester Paper ■</td>
<td>W</td>
<td>8 credits</td>
<td>11A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
Semester Papers help to deepen the students’ knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students’ ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

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<tr>
<td>401-3740-02L</td>
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</tbody>
</table>

Abstract
Semester Papers help to deepen the students’ knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students’ ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

► Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATH:

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

► Master Thesis

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0 credits</td>
<td></td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Target audience:
Third year Bachelor students;
Master students who cannot document to have received an adequate training in working scientifically.

Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later. Optional for Bachelor and Master students with matriculation until or before the spring semester 2014. Example: You matriculated in the autumn semester 2013 into the first semester of the Bachelor programme, are now in the third year and plan to matriculate in the autumn semester 2016 into the first semester of the Master programme. In this case, you don’t need "Scientific Works in Mathematics" in order to complete the Bachelor degree, but for the Master degree you will need it. In this case, we recommend that you register for "Scientific Works in Mathematics" in the autumn semester 2015 or spring semester 2016.

Directive

Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)
Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-4990-01L Master's Thesis
Only students who fulfil the following criteria are allowed to begin with their master's thesis:
1. successful completion of the bachelor programme;
2. fulfilling of any additional requirements necessary to gain admission to the master programme.

For Programme Regulations 2014 there are additional requirements.

No direct enrolment to this course unit in myStudies.
Please fill in the online application form.
Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html
(Afterwards the enrolment will be done by the Study Administration.)

Abstract
The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

Objective
Thesis work should prove the students' ability to independent, structured and scientific working.

Colloquia

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<tr>
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<th>Type</th>
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<th>Lecturers</th>
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</table>

Abstract
Research colloquium

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>151-0122-AAL</td>
<td>Fluid Dynamics for CSE</td>
<td>E-</td>
<td>5</td>
<td>11R</td>
<td>T. Rösgen</td>
</tr>
</tbody>
</table>

Abstract
An introduction to the physical and mathematical foundations of fluid dynamics is given.

Objective
An introduction to the physical and mathematical principles of fluid dynamics. Fundamental terminology/principles and their application to simple problems.

Content
Phänomene, Anwendungen, Grundfragen
Dimensionsanalyse und Ähnlichkeit; Kinematische Beschreibung; Erhaltungssätze (Masse, Impuls, Energie), integrale und differentielle Formulierungen; Reibungsfreie Strömungen: Euler-Gleichungen, Stromfadentheorie, Satz von Bernoulli; Reibungsbehafhte Strömungen: Navier-Stokes-Gleichungen; Grenzschichten; Turbulenz

Lecture notes
Eine erweiterte Formelsammlung zur Vorlesung wird elektronisch zur Verfügung gestellt.

Literature
Empfohlenes Buch: Fluid Mechanics, P. Kundu & I. Cohen, Elsevier

Prerequisites / notice
Performance Assessment: session examination
Allowed aids: Textbook (free selection, list of assignments), list of formulars IFD, 8 Sheets (=4 Pages) own notes, calculator

406-0353-AAL Analysis III
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.
Content

Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling; Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Literature


For reference/complement of the Analysis I/II courses:

Christian Blatter: Ingenieur-Analysis (Download PDF)

Prerequisites / notice

Up-to-date information about this course can be found at:
http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet

406-0603-AAL Stochastics (Probability and Statistics) E- 4 credits 9R M. Kalisch

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables
From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435
  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

406-0663-AAL Numerical Methods for CSE E- 7 credits 15R R. Hiptmair

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology.

Objective
* Knowledge of the fundamental algorithms in numerical mathematics
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
* Ability to choose the appropriate numerical method for concrete problems
* Ability to interpret numerical results
* Ability to implement numerical algorithms efficiently

The course will cover the following chapters:

1. Direct Methods for linear systems of equations
2. Interpolation
3. Iterative Methods for non-linear systems of equations
4. Krylov methods for linear systems of equations
5. Eigensolvers
6. Least Squares Techniques
7. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Clustering Techniques
11. Single Step Methods for ODEs
12. Stiff Integrators

Lecture notes
Comprehensive lecture materials are available upon request from the lecturer.

Literature
M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002
C. Moler, "Numerical computing with MATLAB", SIAM, 2004
P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice
Solid knowledge about fundamental concepts and techniques from linear algebra & calculus as taught in the first year of science and engineering curricula.

**252-0232-AAL Software Design**

*Enrolment only for MSc students who need this course as additional admission requirement.*

**Abstract**
The course Software Design presents and discusses design patterns regularly used to solve problems in object oriented design and object oriented programming. The presented patterns are illustrated with examples from the Java libraries and are applied in a project.

**Objective**
The students
- know the principles of object oriented programming and can apply these.
- know the most important object oriented design patterns.
- can apply design patterns to solve design problems.
- discover in a given design the use of design patterns.

**529-0483-AAL Statistical Physics and Computer Simulation**

*Enrolment only for MSc students who need this course as additional requirement.*

**Abstract**
Principles and applications of statistical mechanics and equilibrium molecular dynamics, Monte Carlo simulation, Stochastic dynamics. Exercises using a MD simulation program to generate ensembles and subsequently calculate ensemble averages.

**Objective**
Introduction to statistical mechanics with the aid of computer simulation, development of skills to carry out statistical mechanical calculations using computers and interpret the results.

**Content**
Principles and applications of statistical mechanics and equilibrium molecular dynamics, Monte Carlo simulation, Stochastic dynamics. Exercises using a MD simulation program to generate ensembles and subsequently calculate ensemble averages.

**Literature**
available

**Prerequisites / notice**
additional information will be provided in the first lecture.

**Computational Science and Engineering Master - Key for Type**

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

**Key for Hours**

| V | lecture | P | practical/laboratory course |
| G | lecture with exercise | A | independent project |
| U | exercise | D | diploma thesis |
| S | seminar | R | revision course / private study |
| K | colloquium |

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Robotics, Systems and Control Master

### Core Courses

<table>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Beck, P. Koumoutsakos</td>
</tr>
</tbody>
</table>

**Abstract**
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control systems, and cell biology.

**Objective**
The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

**Content**
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

**Lecture notes**
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

**Literature**
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

**Prerequisites / notice**
Fundamentals of Probability, Fundamentals of Computational Modeling

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</table>

**Abstract**
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective**
Introduction to HPC for scientists and engineers. Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

**Content**
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

**Lecture notes**
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

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</thead>
<tbody>
<tr>
<td>151-0509-00L</td>
<td>Microscale Acoustofluidics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Dual</td>
</tr>
</tbody>
</table>

**Abstract**
In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

**Objective**
Understanding acoustophoresis, the design of devices and potential applications.

**Content**
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity. Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic micro robotics to surface acoustic wave devices

**Lecture notes**

**Literature**
Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

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</thead>
<tbody>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>R. D’Andrea</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to Dynamic Programming and Optimal Control.

**Objective**
Covers the fundamental concepts of Dynamic Programming & Optimal Control.

**Content**
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

**Literature**

**Prerequisites / notice**
Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

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<tr>
<td>151-0593-00L</td>
<td>Embedded Control Systems</td>
<td>W</td>
<td>4</td>
<td>6G</td>
<td>J. S. Freudenberg, M. Schmid Daners</td>
</tr>
</tbody>
</table>

**Abstract**
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

**Objective**
Familiarize students with main architectural principles and concepts of embedded control systems.
### Content

An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

### Lecture notes

Lecture notes, lab instructions, supplemental material

Prerequisite courses are Control Systems I and Informatics I.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: schmid@idsc.mavt.ethz.ch)

After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

#### 151-0601-00L Theory of Robotics and Mechatronics

<table>
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<tr>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>P. Korba, S. Stoeter, B. Nelson</th>
</tr>
</thead>
</table>

**Abstract**

This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Objective**

Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Content**

An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

**Lecture notes**

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

**Prerequisites / notice**

The course will be taught in English.

#### 151-0604-00L Microrobotics

<table>
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<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>B. Nelson</th>
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**Abstract**

Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**

The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**

Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Lecture notes**

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

**Prerequisites / notice**

The course will be taught in English.

#### 151-0613-00L Fundamentals of Image Processing and Computer Vision

<table>
<thead>
<tr>
<th>W</th>
<th>5 credits</th>
<th>3V</th>
<th>University lecturers</th>
</tr>
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</table>

**Objective**

The objective of this course is to provide the basics required to develop simple image processing and feature extraction algorithms.

**Prerequisites / notice**

Basic knowledge of Math, Physics, Probability theory, C/C++, and Matlab programming are an advantage.

#### 151-0623-00L ETH Zurich Distinguished Seminar in Robotics, Systems and Controls

<table>
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<tr>
<th>W</th>
<th>1 credit</th>
<th>1S</th>
<th>B. Nelson, J. Buchli, R. Gassert, W. Karlen, R. Riener, R. Siegwart</th>
</tr>
</thead>
</table>

**Abstract**

This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls.

**Objective**

Obtain an overview of various topics in Robotics, Systems, and Controls from leaders in the field. Please see http://www.msr.ethz.ch/education/distinguished-seminar-in-robotics--systems--controls--151-0623-0.html for a list of upcoming lectures.

**Content**

This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls. MSc students in Robotics, Systems, and Controls are required to attend every lecture. Attendance will be monitored. If for some reason a student cannot attend one of the lectures, the student must select another ETH or University of Zurich seminar related to the field and submit a one page description of the seminar topic. Please see http://www.msr.ethz.ch/education/distinguished-seminar-in-robotics--systems--controls--151-0623-0.html for a suggestion of other lectures.
The rapid evolution of computing, communication, and information technologies has brought about the
4G
Available

The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic
systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the
art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

The course consists of three parts: First, we will refresh and deepen the student's knowledge in kinematics, dynamics, and rotations of
multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with
the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences
among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged
systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with
related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in
robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today
in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

Prerequisites / notice
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in
Fluid Dynamics.

Introduction to Aircraft and Car Aerodynamics

Abstract
Aircraft aerodynamics: Atmosphere; aerodynamic forces (lift, drag); thrust.
To understand the basic principles and interrelationships of aircraft and automotive aerodynamics.

Objective
An introduction to the basic principles and interrelationships of aircraft and automotive aerodynamics.
Using experimental and theoretical methods to illustrate possibilities and limits.

Content
Airplane aerodynamics: atmosphere, aerodynamic forces (ascending force: profile, wings. Resistance, residual resistance, induced
resistance); thrust (overview of the propulsion system, aerodynamics of the propellers), introduction to static longitudinal stability.
Automobile aerodynamics: Basic principles: aerodynamic force and the force of inertia, resistance, drive, aerodynamic and driving

Literature
1.) Grundlagen der Flugtechnik (Basics of flight science, script in german language)
2.) Einführung in die Fahrzeugaerodynamik (Introduction in car aerodynamics, script in german language)

Lecture notes
English literature covering the content of the course:

Discrete Event Systems

Abstract
Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course
we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages,

Objective
Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the
proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans.
The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a
keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study
processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new
modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event
systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete
event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and
queueing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems
from a worst-case perspective using the theory of online algorithms and adversarial queueing.

Content
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes
Available
Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant
Linear System Theory
F. Dörfler
4G
The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and
M. Morari
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of
J. W. Kolar
W
J. Lygeros
Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including
2V+2U
Control Systems
W
Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand)
227-0103-00L
Control Systems
W
6 credits
2V+2U
M. Morari, F. Dörfler
Objective
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.
Content
Lecture notes
Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF).
Literature
Prerequisites / notice
Prerequisites: Signal and Systems Theory II.
MATLAB is used for system analysis and simulation.
227-0225-00L
Linear System Theory
W
6 credits
5G
J. Lygeros, M. Kamgarpour
Abstract
The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.
Objective
By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.
Content
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.
Lecture notes
Prerequisites / notice
Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.
227-0247-00L
Power Electronic Systems I
W
6 credits
4G
J. W. Kolar
Abstract
Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant DC/DC converters are analyzed in detail and high frequency loss mechanisms of magnetic components are explained. Space vector modulation of three-phase inverters is introduced and the main power components are designed for typical industry applications.
Objective
Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter systems. Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion of three-phase PWM converter systems in the lecture Power Electronic Systems II.
Content
Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching losses are explained. Furthermore, zero voltage switching, zero current switching, and resonant DC/DC converters are discussed in detail; the operating behavior of isolated full bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of three-phase inverter systems are discussed related to voltage DC link inverter systems and the design of the main power components based on analytical calculations is explained.
Lecture notes
Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.
Prerequisites / notice
Prerequisites: Introductory course on power electronics.
227-0447-00L  
**Image Analysis and Computer Vision**  
W  6 credits  3V+1U  G. Székely, O. Göksel, L. Van Gool  

**Abstract**  

**Objective**  
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.  

**Content**  
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.  

**Lecture notes**  
Course material Script, computer demonstrations, exercises and problem solutions  

**Prerequisites**  
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.  
The course language is English.  

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227-0526-00L  
**Power System Analysis**  
W  6 credits  4G  G. Andersson  

**Abstract**  
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.  

**Objective**  
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.  

**Content**  
The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear set of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.  

**Lecture notes**  
Lecture notes. Course is supported by WWW-teaching system.  

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227-0689-00L  
**System Identification**  
W  6 credits  2V+1U  R. Smith  

**Abstract**  
Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data.  

**Objective**  
To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity.  

**Content**  
Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models. Predictive, open-loop, black-box identification methods. Time and frequency domain methods. Subspace identification methods.  

Optional experimental design, Cramer-Rao bounds, input signal design.  

Parametric identification methods. On-line and batch approaches.  

Closed-loop identification strategies. Trade-off between controller performance and information available for identification.  


Control systems (227-0216-00L) or equivalent.  

**Prerequisites**  
Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, etc).  

**Literature**  

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227-0697-00L  
**Industrial Process Control**  
W  4 credits  3G  G. Maier, A. Horch  

**Abstract**  
Introduction to process automation and its application in process industry and power generation.  

**Objective**  
Knowledge of process automation and its application in industry and power generation.  

**Content**  
Introduction to process automation: system architecture, data handling, communication (fieldbusses), process visualization, engineering, etc. Analysis and design of open loop control problems: discrete automata, petri-nets, decision tables, drive control and object oriented function group automation philosophy, RT-UML. Engineering: Application programming in IEC61131-3 (function blocks, sequence control, structured text); Process visualization and operation; engineering integration from sensor, cabling, topology design, function, visualization, diagnosis, to documentation; Industry standards (e.g. OPC, Proftibus). Ergonomic design, safety (IEC61508) and availability, supervision and diagnosis. Practical examples from process industry, power generation and newspaper production.  

**Lecture notes**  
Slides will be available as .PDF documents, see “Learning materials” (for registered students only)  

**Prerequisites**  
Exercises: Tuesday 15-16.  

Practical examples will illustrate some topics, especially some control software coding using industry standard programming tools based on IEC61131-3.  

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227-0778-00L  
**Hardware/Software Codesign**  
W  6 credits  2V+2U  L. Thiele  

**Abstract**  
The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.  

**Objective**  
The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.  

**Content**  
The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration).  

**Lecture notes**  
Material for exercises, copies of transparencies.
Students will be introduced to probabilistic graphical models and will learn how to apply them to problems in image analysis and understanding. The focus will be to study various algorithms for inference and parameter learning.

Outline:
- Dimension reduction: principal component analysis (PCA) and beyond
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Parametric methods: Maximum likelihood estimation
- Non-linear regression and the bias-variance trade-off
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Maximum likelihood and Bayesian parameter inference
- Linear, quadratic and neural networks
- Regression: least squares, ridge and LASSO penalization
- Bayesian theory of optimal decisions
- Bayesian networks
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

The goal of the course is that students should understand the principles of user-centred design and be able to apply these in practice.

Advanced Topics in Computer Graphics and Vision

2V+1U

The course will introduce students to various methods of analysing the user experience, showing how these can be used at different stages of system development from requirements analysis through to usability testing. Students will get experience of designing and carrying out user studies as well as analysing results. The course will also cover the basic principles of interaction design. Practical exercises related to touch and gesture-based interaction will be used to reinforce the concepts introduced in the lecture. To get students to further think beyond traditional system design, we will discuss issues related to ambient information and awareness.

Prerequisites:
- Solid basic knowledge in statistics, algorithms and programming
- Combining logic and probability
- Reinforcement learning
- Probabilistic planning (MDPs, POMDPs)
- Probability
- Tutorial in logic (propositional, first-order)
- Search (BFS, DFS, A*), constraint satisfaction and optimization

Prerequisites / notice
- Students should be familiar with the concepts of logic programming.

Probabilistic Artificial Intelligence

W 4 credits 2V+1U A. Krause

This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

Objective
How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.

Content
Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximate inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites / notice
- Solid basic knowledge in statistics, algorithms and programming
- Number of participants limited to 18.
- The course is open to students of computer science, electrical engineering, and mechanical engineering background (although students from other departments will be considered).

Robotics Programming Laboratory

W 8 credits 7P B. Meyer, J. W. Shin

Number of participants limited to 16.

The course is open to students of computer science, electrical engineering, and mechanical engineering background (although students from other departments will be considered).

In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. Additional Labs will be listed on the Addendum.
Abstract
This course is a hands-on laboratory course in which participants program Thymio II robot that will play in a competition. Students will learn software engineering skills and robotics concepts and apply them in practice.

Objective
- Knowledge of basic software engineering principles and methods
- Knowledge of how software engineering applies to robotics
- Knowledge of the most common architectures, coordination and synchronization methods
- Experience in design of a small robotics system with aspects of sensing, planning and control

Content
- Software engineering tools
- Design patterns
- Software architecture
- ROS and Roboscoop
- Perception
- Mapping and localization
- Path planning and obstacle avoidance

Prerequisites / notice
Students will program Thymio II educational robot with a Carmine 1.09 RGBD camera as the sensor.

Combination of lectures and a semester-long project.

Limited to 18 students.
- Expected to work both individually and in teams of 2-3 students

263-5902-00L Computer Vision W 6 credits 3V+1U+1A M. Pollefeys, L. Van Gool
Abstract
The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

Objective
The objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Content
Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice
It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

376-1279-00L Virtual Reality in Medicine W 3 credits R. Riener, M. Harders
Abstract
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective
Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, rehabilitation.

Content
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of higher semesters and PhD students of
- D-HEST, D-MAVT, D-ITET, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome!

Literature

Prerequisites / notice
The course language is English.
Basic experience in Information Technology and Computer Science will be of advantage
More details will be announced in the lecture.

376-1504-00L Physical Human Robot Interaction (pHRI) W 4 credits 2V+2U R. Gassett, O. Lambercy, R. Riener
Number of participants limited to 26
Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Objective
The objective of this course is to give an introduction to the fundamentals of physical human interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de- sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and prosthetics. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://eduhaptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

The lecture will be held in English.

There are 6 credit points for this lecture.

Prerequisites / notice

Notice:
The registration is limited to 26 students.
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/phri.html

Multidisciplinary Courses

Any courses offered by the Departments of MAVT, ITET or INFK. Your tutor must agree to this choice.
Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MAVT.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Semester Project

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-1014-00L</td>
<td>Semester Project Robotics, Systems and Control Only for Robotics, Systems and Control MSc.</td>
<td>O</td>
<td>8 credits</td>
<td>17A</td>
<td>Professors</td>
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</table>

Abstract
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Objective
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

Internship

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>151-1015-00L</td>
<td>Industrial Internship Robotics, Systems and Control</td>
<td>O</td>
<td>8 credits</td>
<td></td>
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</table>

Abstract
The main objective of the 12-week internship is to expose master's students to the work environment in an engineering company or in a research lab outside of the ETH domain. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective
The main objective of the 12-week internship is to expose master's students to the work environment in an engineering company or in a research lab outside of the ETH domain.

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1016-00L</td>
<td>Master's Thesis Robotics, Systems and Control</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Robotics, Systems and Control Master - Key for Type

| O | Compulsory                                               | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended                      | Z  | Courses outside the curriculum       |
| W  | Eligible for credits                                     | Dr | Suitable for doctorate               |

Key for Hours

| V | lecture                                                 | P  | practical/laboratory course          |
| G | lecture with exercise                                   | A  | independent project                  |
| U | exercise                                                | D  | diploma thesis                       |
| S | seminar                                                 | R  | revision course / private study       |
| K | colloquium                                              |     |                                         |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>860-0003-00L</td>
<td>Cornerstone Science, Technology, and Policy</td>
<td>O</td>
<td>2</td>
<td>3S</td>
<td>T. Bernauer, R. S. Abhari</td>
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<td></td>
<td>Only for Science, Technology, and Policy MSc.</td>
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<td>Abstract</td>
<td>This course introduces students to the MSc program in two ways. First, it provides a general introduction to the study of STP. Second, it exposes students to a variety of complex policy problems and ways and means of coming up with proposals for and assessments of policy options.</td>
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<td>Day 2: Introduction to the study of Science, Technology and Policy</td>
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<td>Day 3: Knowledge assessment in areas marked by controversy over scientific issues</td>
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<td>Day 8: Implications of digital society</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Reserved for the ISTP’s Master students</td>
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<tr>
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<th>ECTS</th>
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<tbody>
<tr>
<td>860-0001-00L</td>
<td>Public Institutions and Policy-Making Processes</td>
<td>O</td>
<td>6</td>
<td>3G</td>
<td>T. Bernauer, S. Bechtold, F. Schimmelfennig</td>
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<td></td>
<td>Priority for ISTP MSc students.</td>
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<tr>
<td>Abstract</td>
<td>Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels.</td>
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<tr>
<td>Objective</td>
<td>Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g. interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.</td>
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<tr>
<td>Content</td>
<td>Schedule:</td>
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<tr>
<td></td>
<td>W1: (no class because of ISTP cornerstone course)</td>
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<td>W2: Bechtold, Bernauer: Introduction</td>
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<td>W3: Bechtold: Why do we need laws and why do people and other actors (e.g. firms) usually obey the law?</td>
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<td>W4: Bechtold: How is law enforced, and when do laws fail to influence the behavior of individuals and other actors (e.g. firms)?</td>
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<td>W5: Bechtold: Courts as policy-makers</td>
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<td>W6: Bernauer: How are parliaments (legislatures) elected, how do they work, and how do their characteristics and processes affect policy-making?</td>
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<td>W7: Bernauer: Why do forms of government differ and how does this affect policy-making? Why and in what respect are public administrations efficient/effective, and why sometimes not?</td>
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<td></td>
<td>W8: Bernauer: How do interest groups and social movements affect policy-making?</td>
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<td></td>
<td>W9: Schimmelfennig: Governance beyond the state: why and how states create international institutions.</td>
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<td>W10: Schimmelfennig: International organizations and regimes: case studies of global governance.</td>
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<td>W11: Schimmelfennig: Governance in the European Union: policy-making and policy enforcement.</td>
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<td>W12: Schimmelfennig: The international diffusion of policies: how states learn from each other.</td>
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<td>W13: study week, Q&amp;A meeting</td>
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<td>W14: End of semester test</td>
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<tr>
<td>Lecture notes</td>
<td>End of January: deadline for review essay</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Reading materials will be distributed to the students before the semester starts.</td>
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<td></td>
<td>This is a Master level course. The course is capped at 25 students, with ISTP Master students having priority.</td>
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<tr>
<td>Abstract</td>
<td>The lectures will introduce students to the principles of quantitative policy analysis, namely the methods to predict and evaluate the social, economic, and environmental effects of alternative strategies to achieve public objectives. A series of graded assignments will give students an opportunity for students to apply those methods to a set of case studies</td>
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<tr>
<td>Objective</td>
<td>The objectives of this course are to develop the following key skills necessary for policy analysts:</td>
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<td>- Identifying the critical quantitative factors that are of importance to policy makers in a range of decision-making situations.</td>
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<td>- Developing conceptual models of the types of processes and relationships governing these quantitative factors, including stock-flow dynamics, feedback loops, optimization, sources and effects of uncertainty, and agent coordination problems.</td>
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<td>- Develop and program numerical models to simulate the processes and relationships, in order to identify policy problems and the effects of policy interventions.</td>
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<td>- Communicate the findings from these simulations and associated analysis in a manner that makes transparent their theoretical foundation, the level and sources of uncertainty, and ultimately their applicability to the policy problem.</td>
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<td>The course will proceed through a series of policy analysis and modeling exercises, involving real-world or hypothetical problems. The specific examples around which work will be done will concern the environment, energy, health, and natural hazards management.</td>
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<tbody>
<tr>
<td>860-0004-00L</td>
<td>Bridging Science, Technology, and Policy</td>
<td>O</td>
<td>3</td>
<td>2S</td>
<td>R. S. Abhari, T. Bernauer</td>
</tr>
<tr>
<td></td>
<td>Only for Science, Technology, and Policy MSc.</td>
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<tr>
<td>Abstract</td>
<td>This course picks up on the cornerstone course and goes into greater depth on issues covered in that course, as well as additional issues where science and technology are among the causes of societal challenges but can also help in finding solutions.</td>
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Objective

This course picks up on the cornerstone course and goes into greater depth on issues covered in that course, as well as additional issues where science and technology are among the causes of societal challenges but can also help in finding solutions.

Week 1: (no class because of ISTP cornerstone course)
Week 2: Urban development
Week 3: Urban development
Week 4: Energy transitions
Week 5: Energy transitions
Week 6: Climate change
Week 7: Climate change
Week 8: International water management
Week 9: International water management
Week 10: Digital society
Week 11: Digital society
Week 12: Genetic engineering and synthetic biology
Week 13: Minerals
Week 14: end of semester exam

860-0005-00L


Abstract

Presentations by invited guest speakers from academia and practice/policy. Students are assigned to play a leading role in the discussion and write a report on the respective event.

Objective

Presentations by invited guest speakers from academia and practice/policy. Students are assigned to play a leading role in the discussion and write a report on the respective event.

860-0006-00L

Statistical Data Analysis

Number of participants limited to 20.

Abstract

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

Objective

Students
- have a sound understanding of linear and logit regression
- know some basics about regression models for multinomial, ordered, or censored response variables, as well as for count data
- know strategies to test causal hypotheses using regression and quasi-experimental methods
- are able to formulate and implement a regression model for a particular research question and a particular type of data
- are able to critically interpret results of a regression model, in particular, regarding causal inference

Content

The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinomial or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

860-0007-00L

Principles of Economics

Only for Science, Technology, and Policy MSc.

Abstract

This course is an introduction to the study of economics. Students will learn about the economic way of thinking, the functioning of a market economy, as well as the potentials and limitations of economic policies to govern the behavior of individuals and the economy. The course is divided into two parts, the first covering microeconomic analysis, and the second on macroeconomics.

Objective

The first part of the course focuses on microeconomic analysis, including the behavior of individuals and firms, supply and demand analysis, and market failures. Students will also be introduced to the use of microeconomic thought to influence the behavior of individuals and firms and to address market failures.

The second part focuses on macroeconomic concepts, including national production, employment, inflation, and growth theories. Students will then learn about macroeconomic policies, such as monetary and fiscal policy, often used to stabilize short-run economic fluctuations.

Lecture notes

Lecture slides will be made available in the ILIAS repository, accessible to students via myStudies.

Literature


Ejectives

Number Title Type ECTS Hours Lecturers

851-0585-15L Complexity and Global Systems Science W 3 credits 2V D. Helbing, L. Sanders

Abstract

This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

Objective

Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

Content

This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “tipping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.

Prerequisites / notice

Mathematical skills can be helpful

860-0011-00L Modelling and Simulating Social Systems with MATLAB (with Coding Project) Only for MSc Science, Technology, and Policy.

W 6 credits 2S+2A D. Helbing, O. Woolley, S. Ballelli, L. Sanders

Abstract

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

Objective

Students
- have a sound understanding of linear and logit regression
- know some basics about regression models for multinomial, ordered, or censored response variables, as well as for count data
- know strategies to test causal hypotheses using regression and quasi-experimental methods
- are able to formulate and implement a regression model for a particular research question and a particular type of data
- are able to critically interpret results of a regression model, in particular, regarding causal inference

Content

The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinomial or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

Lecture notes

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Literature


Ejectives

Number Title Type ECTS Hours Lecturers

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Prerequisites / notice

Mathematical skills can be helpful

860-0011-00L Modelling and Simulating Social Systems with MATLAB (with Coding Project) Only for MSc Science, Technology, and Policy.

W 6 credits 2S+2A D. Helbing, O. Woolley, S. Ballelli, L. Sanders

Abstract

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

Objective

Students
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Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

Lecture notes

Lecture slides will be made available in the ILIAS repository, accessible to students via myStudies.

Literature

Abstract
This course introduces the mathematical software package MATLAB.
Students should learn to implement models of various social processes and systems, and document their skills by a seminar thesis, a short oral presentation as well as a coding project.

Objective
The students should learn how to use MATLAB as a tool to solve various scientific problems. MATLAB is an integrated environment with a high level programming language which makes it possible to quickly find numerical solutions to a wide range of scientific problems. Furthermore, it includes a rich set of tools for graphically presenting the results.

After the students have learned the basic structure of the programming language, they should be able to implement social simulation models in MATLAB and document their skills by a seminar thesis, a coding project and finally give a short oral presentation.

351-0778-01L Discovering Management (Exercises) W Dr 1 credit 1U P. Frauenfelder
Complementary exercises for the module Discovering Management.
Prerequisite: Participation and successful completion of the module Discovering Management (351-0778-00L) is mandatory.

Abstract
This course is offered complementary to the basis course 351-0778-00L, “Discovering Management”. The course offers additional exercises and case studies.

Objective
This course is offered to complement the course 351-0778-00L. The course offers additional exercises and case studies.

Content
The course offers additional exercises and case studies concerning:
- Strategic Management; Technology and Innovation Management; Operations and Supply Chain Management; Finance and Accounting; Marketing and Sales.

Please refer to the course website for further information on the content, credits conditions and schedule of the module: www.dm.ethz.ch

Entry level course in management for BSc, MSc and PHD students at all levels not belonging to D-MTEC. This course can be complemented with Discovering Management (Exercises) 351-0778-01.

Abstract
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students’ technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective
Discovering Management offers an integrated learning system, which combines in an innovate format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves ‘learning by doing’. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated activities: 1) the interactive case studies and exercises, 2) the business game simulation.

By discovering these aspects, students should learn how to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guest from established corporations and have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participants’ appreciation for the complex tasks companies deal with.

Discovering Management attempts to overcome the limitations of traditional teaching curricula of management in technical universities, which often merely focus on transferring specific skills to students, e.g. planning or forecasting. In response to the new challenges for entrepreneurial decision-making, students will be offered the opportunity to actively engage in an advanced business game simulation; a business game that establishes a link between business management theory and business management in practice. The simulation presents a realistic model of a company and provides participants with the opportunity to quickly gain the lasting effects of practical experience in a risk-free environment. All this provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyze the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

Prerequisites / notice
Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

Science, Technology, and Policy Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Sport Teaching Diploma

The programme "Teaching Diploma, Two Subjects in One-Step Procedure" will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

► Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-15L</td>
<td>Designing Educational Environments in Physical Education (EW2 Sport)</td>
<td>O</td>
<td>4</td>
<td>2S</td>
<td>H. Gubelmann, R. Scharpf</td>
</tr>
<tr>
<td></td>
<td>Compulsory course requirements for EW2 Sport: This course is required to be taken prior to EW4 Sport &quot;Outdoor Education: Concepts and Practice&quot; (851-0242-02L)</td>
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<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Students learn principles of teaching beyond classroom and regular PE-Lessons :</td>
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<td></td>
<td>- Planning and organizing camps and events</td>
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<td></td>
<td>- Teaching the &quot;Ergänzungsfach Sport&quot;</td>
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<td></td>
<td>- Long-term-curricula in PE</td>
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<td></td>
<td>As a practical part students design the Outdoor event in EW4 of the following term</td>
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<td>Objective</td>
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<td></td>
<td>Students know</td>
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<td></td>
<td>- How to plan events and camps</td>
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<td></td>
<td>- To assess curricula critically and to use them properly</td>
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<td></td>
<td>- How to combine theoretical and practical issues in the &quot;Ergänzungsfach&quot;</td>
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<td></td>
<td>Content</td>
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<td></td>
<td>1. LV Semestereinführung</td>
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<td></td>
<td>2. LV Planung Outdoor-Weekend</td>
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<td>3. LV Auswertung Outdoor-Event</td>
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<td>4. LV Planung Event</td>
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<td>5. LV Event-Präsentation / Schlussveranstaltung</td>
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<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>EW2 is compulsory requirement for EW4 Sport</td>
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<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about learning in childhood and adolescence.</td>
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<td>Abstract</td>
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<tr>
<td></td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<td></td>
<td>Content</td>
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<td>Thematische Schwerpunkte:</td>
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<tr>
<td></td>
<td>Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede bei Lernen</td>
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<td>License forms:</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>Folien werden zur Verfügung gestellt.</td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs &quot;Lehrdiplom&quot; or &quot;Didaktisches Zertifikat&quot;. It is about learning in childhood and adolescence.</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW1)&quot;.</td>
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<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods.</td>
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<td>In the first meeting, working groups will be assembled and two further meetings will be set up.</td>
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<td>In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<tr>
<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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</tbody>
</table>

► Subject Didactics in Sport

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0203-00L</td>
<td>Mentored Work Subject Didactics Sport A</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>O. Graf</td>
</tr>
<tr>
<td></td>
<td>Only for Sport Teaching Diploma students.</td>
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<tr>
<td></td>
<td>Simultaneous enrolment in Mentored Work Subject Didactics Sport A and B is compulsory</td>
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</tbody>
</table>
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective: planning and organization of a longer period of instruction in school.

Content: connection of educational goals and instruction

Lecture notes: see moodle 00 - Lehrdiplom Sport


Disler P., Dida-Methodische Modelle in der Ausbildung, Dissertatioin in 2004, 152
Hotz A., Qualitatives Bewegungserleben, Sportpädagogische Perspektiven einer kognitiv akzentuierten Bewegungslernen in Schlüsselbegriffen, Zurnik SVSS Verlag 1996;1998/2
Loosch E., Allgemeine Bewegungslernen, Limpert Verlag Wiesbaden 1999
Loosch E., Allgemeine Bewegungslernen, Limpert Verlag Wiesbaden 1999
Röthig P. & K. Willemzcik, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999
Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003
Röthig P. & s. Grössing (Hrsg.) Bewegungslernen, Kursbuch 3, Wiesbaden 1990/3

557-0204-00L Mentored Work Subject Didactics Sport B

O 2 credits 4A O. Graf

Simultaneous enrolment in Mentored Work Subject Didactics Sport A and B is compulsory.

Abstract: In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective: planning and organization of a longer period of instruction in school.

Content: connection of educational goals and instruction

Lecture notes: see moodle 00 - Lehrdiplom Sport


Disler P., Dida-Methodische Modelle in der Ausbildung, Dissertatioin in 2004, 152
Hotz A., Qualitatives Bewegungserleben, Sportpädagogische Perspektiven einer kognitiv akzentuierten Bewegungslernen in Schlüsselbegriffen, Zurnik SVSS Verlag 1996;1998/2
Loosch E., Allgemeine Bewegungslernen, Limpert Verlag Wiesbaden 1999
Loosch E., Allgemeine Bewegungslernen, Limpert Verlag Wiesbaden 1999
Röthig P. & K. Willemzcik, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999
Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003
Röthig P. & s. Grössing (Hrsg.) Bewegungslernen, Kursbuch 3, Wiesbaden 1990/3

557-0315-00L Sport Didactics I

O 4 credits 2V R. Scharpf, O. Graf

Simultaneous enrolment in Introductory Internship Sport - course 557-0210-00L - is compulsory.

Abstract: Practical implementation in sports of general didactics, with the planning, implementation and evaluation of topics from all the sport-specific areas of tuition in secondary school Level II.

Objective: The students:
- Implement the objectives of general didactics in respect of the different types of sport at school.
- master the planning, implementation and evaluation of topics from all the sport-specific areas of tuition.
- gain an overview of the preparation necessary for the different requirements placed on a sports teacher at secondary school Level II.
- try out different teaching structures, such as the lesson, teaching unit, block periods and extra units in sport in addition to those on the timetable.

Content: Implementation of practical sport into general teacher training with planning, execution and evaluation of the topics from all sport-specific areas of the education at this level in Section II.


Prerequisites / notice: Lehrdiplom-Studierende müssen die Fachdidaktik Sport I zusammen mit dem Einführungspraktikum Sport - LE 557-0210-00 - belegen.

Professional Training in Sport

Important: You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

Professional Training (First Subject)

Number Title Type ECTS Hours Lecturers

557-0210-00L Introductory Internship Sport

O 3 credits 6P O. Graf, R. Scharpf

Simultaneous enrolment in Sport Didactics I - course 557-0315-00L - is compulsory.

Abstract: During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

Objective: Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

Content: Students observe and teach 5 lessons, supervised by experienced teachers.
Lecture notes
see moodle 00 - Lehrdiplom Sport
https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php

Literature
Diler P., Dida-Methodische Modelle in der Ausbildung, Dissertation in 2004, 152
Loosch E., Allgemeine Bewegungsliehe, Limpert Verlag Wielbelheim 1999
Roth K. & K. Willemszic, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999
Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003
Röthig P. & s. Grössing (Hrsg.) Bewegungsliehe, Kursbuch 3, Wiesbaden 1990/3

557-0208-00L Teaching Internship Sport I O 8 credits 17P O. Graf, R. Scharpf
Only for Sport Teaching Diploma students.

Abstract
The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

Objective
Students use their disciplinary skills and educational knowledge for teaching. They know how to judge topics of their subject and can present them in class. Teaching and classroom management in practice is the main target of this course; students have to find a balance between instruction and self-determined activity of their pupils. Together with their supervisors they learn to assess their tasks and achievements.

Content
Teaching and observation of 50 Sports lessons, supervised by experienced teachers. Students apply their theoretical background in practice. By teaching sports lessons they improve their teaching skills and classroom management and learn how to interact with pupils. Together with their supervisor they develop an ability of critical reflection of their tasks.

Lecture notes
see moodle 00 - Lehrdiplom Sport
https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php

Literature
Diler P., Dida-Methodische Modelle in der Ausbildung, Dissertation in 2004, 152
Loosch E., Allgemeine Bewegungsliehe, Limpert Verlag Wielbelheim 1999
Roth K. & K. Willemszic, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999
Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003
Röthig P. & s. Grössing (Hrsg.) Bewegungsliehe, Kursbuch 3, Wiesbaden 1990/3

Prerequisites / notice
Voraussetzung für das Unterrichtspraktikum ist ein abgeschlossenes Einführungspraktikum und die Fachdidaktik I.

557-0209-00L Teaching Internship Sport II W 4 credits 9P R. Scharpf
Teaching Internship for students upgrading TC to Teaching Diploma.

Abstract
This is a supplement to the Teaching Internship required to obtain a Teaching Diploma in Sports. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.

Objective
Practice in sports teaching into special didactics with planning, execution and evaluation of the topics from all sport-specific areas of the education at this level in Section II.

Content
Teaching and observation of 50 Sports lessons, supervised by experienced teachers.

Lecture notes
Skript unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117

Literature
Diler P., Dida-Methodische Modelle in der Ausbildung, Dissertation in 2004, 152
Loosch E., Allgemeine Bewegungsliehe, Limpert Verlag Wielbelheim 1999
Roth K. & K. Willemszic, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999
Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003
Röthig P. & s. Grössing (Hrsg.) Bewegungsliehe, Kursbuch 3, Wiesbaden 1990/3

557-0215-00L Professional Exercises O 2 credits 4G R. Scharpf
Only for Sport Teaching Diploma students.

Abstract
- Expanding the professional fields of sports tuition.
- Application of special forms of teaching and learning in sports tuition.
- Project work in leisure-time sport and tourism.
- Application of the didactic handling skills and core competences.

Objective
Expanding sports competence in the context of out-of-school projects. Opening up new areas of activity in sport.
Die Studierenden verknüpfen allgemeine Bildungsziele mit allgemeinen und speziellen Lernzielen des Sportunterrichts.

Sie kennen unterschiedliche Lehr/Lernkonzepte und ihre Stärken und Schwächen und sind in der Lage, verschiedene Konzepte situationsbezogen umzusetzen.

Sie interessieren sich für die Bewegungslernprozesse und Denkprozesse von Lernenden. Sie lernen zu erkennen, dass Fehler der Lernenden einen momentanen Ausdruck ihrer biomechanischen Möglichkeiten darstellen.

Sie begegnen den Lernschwierigkeiten mit dem Prinzip der «Variation im Sportunterricht» im Erschweren und Erleichtern der Lernaufgaben.

Sie setzen ihr Wissenswissen ein, um bewegungstheoretische oder bewegungspraktische Lernprozesse anzustoßen und zu begleiten.

Sie berücksichtigen Erkenntnisse aus der fachdidaktischen Forschung und kennen bei unterschiedlichen Inhalten verschiedene Zugänge als Grundlage für ihr Unterrichtsdesign.

Sie implementieren wissensbasierte Methoden aus der allgemeinen Didaktik adäquat und fantasievoll und mit dem Ziel, den Unterricht nachhaltig zu gestalten.

Sie können sich mündlich und schriftlich sachlich korrekt, verständlich und ansprechend ausdrücken.

Sie wissen um die Genderproblematik und begegnen ihr v.a. im koedukativen aber auch im seedukativen Sportunterricht mit geeigneten Maßnahmen.


Lecture notes
Skript unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117>

Literature
- Röthig P. & S. Grössing (Hrsg.) Bewegungslehre, Kursbuch 3, Wiesbaden 1990/3
- Schorndorf 1992 (1977)
- Loosch E., Allgemeine Bewegungsglehrle, Limpert Verlag Wiesbaden 1999
- Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003
- Röthig P. & S. Grössing (Hrsg.) Bewegungslehre, Kursbuch 3, Wiesbaden 1990/3

557-0211-01L Examination Lesson I Sport O 1 credit 2P R. Scharpf, O. Graf
Only for Sport Teaching Diploma students.

Simultaneous enrolment in “Examination Lesson II Sport” (557-0211-02L) is compulsory.

Abstract
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Objective
On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content
Die Studierenden erfahren das Lektionsthema in der Regel eine Woche vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten

Prerequisites / notice
Nach Abschluss der übrigen Ausbildung.

557-0211-02L Examination Lesson II Sport O 1 credit 2P R. Scharpf, O. Graf
Only for Sport Teaching Diploma students.

Simultaneous enrolment in “Examination Lesson I Sport lower” (557-0211-01L) is compulsory.

Abstract
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Objective
On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content
Die Studierenden erfahren das Lektionsthema in der Regel eine Woche vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten

Prerequisites / notice
Nach Abschluss der übrigen Ausbildung.

Professional Training (Two Subjects in One-Step Procedure)
The programme “Teaching Diploma, Two Subjects in One-Step Procedure” will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

Number Title Type ECTS Hours Lecturers
557-0212-00L Teaching Internship Sport Teaching Internship Sport for Teaching Diploma in 2 Subjects in One-Step Procedure and Sport as Major Subject. O 6 credits 13P O. Graf

Students will improve their teaching skills and knowledge by instructing and observing sports lessons.

Lecture notes
see moodle 00 - Lehrdiplom Sport
https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php

Prerequisites / notice
Voraussetzung für das Unterrichtspraktikum ist ein abgeschlossenes Einführungspraktikum und die Fachdidaktik I.

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Internship Including Examination Lessons</td>
<td>1 credit</td>
<td>9P</td>
<td>O. Graf</td>
<td></td>
</tr>
</tbody>
</table>

Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.

Objective
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Content
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practically find the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.

Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

Die Themen für die beiden Prüflungselektungen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Lecture notes
see moodle 00 - Lehrdiplom Sport
https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php

Literature
Bucher et al., Sporterziehung. Bände 1-6. Bern
Loosch E., Allgemeine Bewegungslehre, Limpert Verlag Wiesbaden 1999
Roth K. & K. Willecmzk, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999
Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003
Röthig P. & s. Grössing (Hrsg.) Bewegungslernen, Kursbuch 3, Wiesbaden 1990/3

Teaching Diploma in 2 Subjects in One-Step Procedure: no courses from this category have to be completed.

Specialized Courses in Respective Subject with Educational Focus I

At least 6 CP’s must be obtained in this category.

Number | Title | Type | ECTS | Hours | Lecturers |
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1033-00L</td>
<td>History of Sports</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Gisler</td>
</tr>
<tr>
<td>376-1107-00L</td>
<td>Sport Pedagogy</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>D. Seiler Hubler</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1033-00L</td>
<td>History of Sports</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Gisler</td>
</tr>
</tbody>
</table>

Abstcht for comprehension and changes of sports from the ancient world to the present.

Objective
Understanding the development and adaptation of sports from the ancient world to present times.

Content

Lecture notes
Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1107-00L</td>
<td>Sport Pedagogy</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>D. Seiler Hubler</td>
</tr>
</tbody>
</table>

Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

Objective
To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Content
Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik
- Bedeutung des Sports im Kindes- und Jugendalter
- Leistungssport im Kindes- und Jugendalter
- Pädagogische Perspektiven des Sportunterrichts in der Schule
- Ein zeitgemäßer Schulsport
- Bewegungskulturelle Bildung: Bewegungserziehung, Spielerziehung

### 376-1117-00L  
**Sport Psychology**

**Abstract**
This lecture is intended as an introduction to sport psychology and impart knowledge on selected areas of the subject.

**Objective**
- Students are given insight into different work areas of sport psychology.
- In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students’ expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

**Content**
- Main Topics
  - Introduction to sport psychology
  - Cognitions in sports: mental rehearsal and mental training
  - Emotions and stress
  - Motivation: goal-setting in sports
  - Career and career transition in elite sport
  - Coach-Athlete-Interaction
  - Psychological aspects of sport-injury rehabilitation
  - Group dynamics in sport

**Literature**

**Lecture notes**
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

**Data:** 06.12.2018 13:04  
**Autumn Semester 2015**  
**Page 1265 of 1432**
Prerequisites / notice

- Motor-Learning im Sport (Fachbereich Sportpsychologie)
- Praktische Umsetzung von Forschungsprojekten für die Schule
- Sport im Spannungsfeld zwischen Ethik und Kommerz (Fachbereich Sportssoziologie)
- Praktische Umsetzung von Forschungsprojekten für die Schule
- Mehreckspektivität im Sportunterricht (Fachbereich Sportpädagogik)
- Praktische Umsetzung von Forschungsprojekten für die Schule
- Historische Entwicklung der Lehr- und Lernmodell im Sportunterricht (Fachbereich Sportgeschichte)
- Praktische Umsetzung von Forschungsprojekten für die Schule
- Praktische Umsetzung der Erkenntnisse für die Schule

Specialized Courses in Respective Subject with Educational Focus II

At least 6 CP's must be acquired in this category. Further courses must be chosen from the "Sport Practical: Major Education and Specialized Education".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0206-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Sport B</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>R. Scharpf</td>
</tr>
</tbody>
</table>

Abstract
Refurbishment of research projects dealing with motor competencies in sport and professional scientific content related to this area.
Competent "didactical implementation" of research content. The Fachwissenschaftliche Vertiefung II orientates itself to the guiding principles of cognitive, conditional and coordination aspects of movement.

Objective
Connection of sport and human movement science and educational instruction.

Content
Scientific analysis of sports disciplines in order to improve instruction

Lecture notes
Sklpt unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117>

Literature
See specific subjects

Prerequisites / notice
Mentorated paper in selected sports disciplines.

Compulsory Elective Courses

At least 6 CP's must be acquired in this category. Further courses must be chosen from the "Sport Practical: Major Education and Specialized Education".

a) the course 557-0215-00L "Professional Exercises" must be completed within the category Compulsory Elective Courses;
b) courses from the category Compulsory Elective Courses of the Minor Subject may also be selected;
c) courses from the category Specialized Courses in the Respective Subject, either of the Major or the Minor Subject, may also be selected.

Sport Practical

The Teaching Diploma in Sport - or in Sport as major subject for a Teaching Diploma in a major and a minor subject - will only be granted to students holding a Master, Diploma or Licentiate degree in Sport. Additionally, a Sport Practical encompassing 56 CP's is required. The Sport Practical can be partly conducted during the Bachelor and Master programmes in Sport.

Assessments

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0103-00L</td>
<td>Assessment II Only for Health Sciences and Technology BSc and Teaching Diploma Sport.</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>A. Krebs, S. Nüssli, S. Schoch</td>
</tr>
</tbody>
</table>

Abstract
The assessment II 'achievement' allows students to continue their studies in the basic subjects of athletics, fitness, swimming, ice sports and trend sports. Aim is to acquire the basic skills for the respective sports discipline.

Objective
The assessment monitors both the physical fitness of the students and their skills in the fields of athletics and fitness, which forms the basis for a successful rounding off of the respective direction of study.

Content
Im Assessment II Leisten werden einige Elemente der Sportarten Fitness und Leichtathletik erworben. Unter anderem Grundschnitte Aerobic, wesentliche Übungen zur Körperkräftigung, Gewandheit, Hochsprung, Kugelstossen und Ausdauer.

Prerequisites / notice
Kenntnisse (Schulniveau) in den Sportfächern Fitness und Leichtathletik werden ebenso vorausgesetzt wie angemessene körperliche Fähigkeiten.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0101-00L</td>
<td>Assessment I Only for Health Sciences and Technology BSc and Teaching Diploma Sport.</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>B. Mattli Baur, M. M. Jaeggi, C. König</td>
</tr>
</tbody>
</table>

Abstract
To acquire basic movements on various apparatuses and in acrobatics as well as to create individual and cooperative combinations according to qualitative criteria.

Objective
The students should be able to:
- acquire and consolidate apparatus related core movements as well as apply and create such combinations
- utilize their own strength as well as the resulting impact in a differentiate way in order to precisely move the swinging, flying, falling and twisting body
- gain orientation safety and equilibrium while twisting and flying
- Rhythmised attainment of specific acrobatic requirements with music
- Change of positions on the trampoline respecting coordinative aspects
- Accomplishment of an Indoor Parkour

### Basic Education

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 557-0412-01L | Dance I  
Prerequisites: Practical course Movement Sciences I (BSc HMS) or Assessment I (BSc HST).  
Compulsory for Sport Teaching Diploma, new Programme Regulations. | W    | 2    | 2G    | C. König      |
|          | Abstract  
Dance and movement comprise of expression, strength, endurance, suppleness, flexibility, rhythmic movement sequences, coordination and dance cant with music - combined with creativity. Implementation of these aspects.  
Objective  
- To arouse and stimulate the interest for dancing  
- To enjoy dancing without prior knowledge and to experience the possibilities within dance from easy to hard  
- To gain insight into different dance styles  
- To improve one's own dance technique in framework of the topics offered: To acquire and expand personal skills and knowledge  
- To expand the diversity and repertoire of movements  
- To improve coordination with the help of music  
- To understand music and to be able to interpret the music's character  
- Dance enhances the consciousness about body and posture, helps in a holistic personality development and assists in body language: a way to express emotions  
Content  
- Kennenlernen von verschiedenen Tanzstilen: HipHop/Streetdance, Jazz, Jive (RNR), Salsa...  
- Grundlagen von Techniken einzelner Tanzstile kennenlernen und verbessern  
- Erarbeiten von Tanzkombinationen  
- Der Tanz und die Bewegung beinhalten Ausdruck, Kraft, Ausdauer, Geschmeidigkeit, Flexibilität, rhythmische Bewegungsabläufe, Koordination und Tanzphrasen mit Musik gepaart mit Kreativität und Lebensfreude |
| 557-0433-00L | Apparatus Gymnastics and Trampoline I  
Prerequisites: Practical course Movement Sciences I (BSc HMS) or Assessment I (BSc HST).  
Compulsory for Sport Teaching Diploma, new Programme Regulations. | W    | 2    | 2G    | B. Mattli Baur, M. M. Jaeggi |
|          | Abstract  
To get to know and understand the basics of movement (core movements) and its respective actions and functions on apparatuses, on the floor and in acrobatics as well as to create individual and cooperative combinations according to qualitative criteria.  
Objective  
The students should be able to:  
- acquire and consolidate apparatus related core movements as well as apply and create such combinations  
- utilize their own strength as well as the resulting impact in a differentiate way in order to precisely move the swinging, flying, falling and twisting body  
- gain orientation safety and room orientation while twisting and flying  
- gain sensitivity for social competences (e.g. to assist, to observe, to advise) within a small group.  
Content  
- structural relationships within rotations (turnarounds, handsprings and free somersaults)  
- acrobatic cooperation in a threesome on a course of apparatuses  
- core poses as motor basic training  
- variety of position modifications in handstands  
- core movements and combinations on parallel bars, high bar, floor and in swinging rings  
- different forms of vaulting as well as springing in movements like handstands and somersaults  
Literature  
- Trampolinschule nach der Part-Methode, BASPO 2013 |
| 557-0503-01L | Basketball - Basics  
Prerequisites: Practical course Movement Sciences I-III (BSc HMS) or Assessment III (BSc HST).  
Compulsory for Sport Teaching Diploma, new Programme Regulations. | W    | 2    | 2G    | C. Schaudt    |
|          | Abstract  
Basketball - Basics: Basic technical skills: shooting, passing, dribbling / ballhandling, related to the specific Basketball rules. (Pre-)tactical skills: from 1 : 0 through 3 : 3, preparing 5 : 5  
Objective  
Basics of Basketball (technical and tactical skills) up to level 3 vs. 3. With these learnings the game 5 vs. 5 can be played easily, though it is not a primary topic of this event.  
Content  
Basic technical skills: shooting, passing, dribbling / ballhandling, related to the specific Basketball rules.  
Tactical skills: from 1 : 0 through 3 : 3, preparing 5 : 5  
Lecture notes  
no specific script |
**Literature**

- manual for monitors of the Swiss Youth & Sports program (available through the "Jugend & Sport" office, german / french / italian)
- Chervet, Michel: *Basketball. Fundamental skills for offensive play. Video* (german / french). Maggbingen, BASPO, 2003 (CHF 34.-). Order at video@baspo.admin.ch

**557-0514-03L Soccer I**

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>H. A. Russheim, P. C. Humbel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical course Movement Sciences -III (BSc HMS) or Assessment III (BSc HST).</td>
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</tbody>
</table>

**Abstract**

Acquisition/consolidation basic skills for soccer.

**Objective**

Support and development the individual conditions/talent/skill and introduction of basic methods will be treated.

**Content**

- Technique:
  - Dribble, short passport play, get the ball under control, shot,
  - Individual tactics:
    - offensive/defensive 1vs1; keep ball in own rows
  - various contests in support of different techniques and tactics

**Literature**

- Bucher, Walter (Hrsg.) 1020 Spiel- und Übungsformen im Kinderfussball, 7. unveränderte Auflage 2011, Hofmann-Verlag, Schorndorf

**Prerequisites / notice**

1. Prerequisites:
   - Small being able in soccer.
   - Readiness to train.
2. After this course you can get the licence "manager for children". Prerequisites: Only 1 absence from the lessons "football for children", the book "Kinderfußball" can be bought in the course

**557-0533-01L Floorball I**

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>B. Beutler, F. Ungrad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical course Movement Sciences I-III (BSc HMS) or Assessment III (BSc HST).</td>
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</tbody>
</table>

**Abstract**

Experiencing Unihockey/Floorball as an indoor sportsgame Learning by doing to improve personal sport skills and widening personal abilities in ball sports Learning by practising/playing and linking that knowledge to theories of motor learning

**Objective**

Practising unihockey to improve personal sport skills and widening personal abilities in ball sports Improvement of personal unihockey-skills Learning by practising/playing and linking that knowledge with theories of motor learning

**Content**

- Transfer of ideas into motor movements and motor skills
- Personal improvement by practising different motor skills as moving the ball/ballcontrol, passing, shooting
- Analysis of personal sports abilities in ballgames
- Understanding, learning and applying the rules of the game Practical test of skills and in game activities at the end of the semester

**Lecture notes**

Classes are based on insights from the book "unihockey basics" by B.Beutler, M.Wolf.

**Literature**


**Prerequisites / notice**

Please bring your personal hockey stick with you to class.

**557-0603-00L Snowsport I**

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>P. Disler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment I+II (BSc HST)</td>
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</tbody>
</table>

**Abstract**

Education in the disciplines of winter sports (ski or snowboard)

**Objective**

The students:
- experience the different winter sports
- gain an understanding of how to ski off-piste

**Content**

To apply and vary personal technique of alpine skiing
To apply and vary personal technique of snowboarding
To acquire and vary personal technique of cross-country skiing
To gain an understanding in how to ski off-piste

**Prerequisites / notice**

Requirement: Assessment I + II (BSc HST)

**557-0609-00L Trendsports**

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>R. Scharpf, O. Graf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants limited to 72.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>Assessment II passed (BSc HST) or</th>
</tr>
</thead>
</table>
Students learn basic skills of new sports which are taught in school but are not yet part of teachers training. They improve their personal skills and demonstrate the game in teams as well as groups of 4 against 4. The students improve their personal skills with an individual emphasis on game and practice. The introduced technical elements form the requirements for the tactically-orientated zone plays and are exclusively trained in the execution and formation steps.

### Objective
- The students improve their personal skills and demonstrate the game in teams as well as groups of 4 against 4.
- They deepen the development of the game.
- They improve their personal skills with an individual emphasis on game and practice.

### Content
- Spielend Handball lernen - Über das Spiel zum Spiel (Vom Spiel 3/3 zum Spiel 4/4)
- Die Spielentwicklung erfolgt über die Zonenspiele vom Spiel (2/1) 3/2 zum Spiel 4/4 (6/6).
- Die eingeführten technischen Elemente bilden die Voraussetzung für die vorwiegend taktisch ausgerichteten Zonenspiele und werden ausschließlich in der Anwendungs- und Gestaltungsstufe trainiert.
- Techniktraining ist Sache der Studierenden.
- Die individuelle Grundschulung wird mit Lernkontrollen überprüft (Kontrollblätter). Alle ausgewählten Formen müssen als Lernkontrolle durchführbar sein.

### Lecture notes
Lehrunterlagen können von der Homepage abgerufen werden.

### Literature
- Lehrunterlagen können von der Homepage abgerufen werden.
- Literatur
  - Obligatorisch Spielerziehung O. Buholzer SHV Kosten Fr. 15.
  - Obligatorisch Spielend Handball lernen A. Emrich Limpert Kosten Fr. 20.
  - Freiwillig Spielen lernen M. Ochsenbein/ O. Buholzer SHV Kosten Fr. 15.
  - Freiwillig Technik lernen O. Buholzer SHV
- Muss selbständig erworben oder bei Semesterbeginn bestellt werden.

### Prerequisites / notice
- Testatbedingungen: Präsenz:
  - Maximale Abwesenheiten (3 entschuldigte und 3 unentschuldigte Absenzen)
  - Testübungen: Im Rahmen der Ausbildung werden Zonenspiele und Fertigkeiten erarbeitet. Für das Testat müssen insgesamt 6 Testübungen aus mind. 4 praktischen Bereichen abgegeben werden.

### Prüfungen
- Inhalte: Die Prüfungsinhalte werden während des Semesters erarbeitet und am Ende des Semesters schriftlich abgegeben.

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### Major Education

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0516-03L</td>
<td>Soccer II</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>P. C. Humbel, H. A. Russheim</td>
</tr>
<tr>
<td></td>
<td>Prerequisites: Basic course completed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Acquisition/consolidation basic skills for the soccer.</td>
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<tr>
<td>Objective</td>
<td>Support and development the individual conditions/talent/skill and introduction of basic methods will be treated.</td>
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<tr>
<td>Content</td>
<td>Support and development the individual conditions/talent/skill and introduction of basic methods will be treated.</td>
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<tr>
<td>Literature</td>
<td>Dribble; pass the ball, get the ball under control, shot, throw-in, header</td>
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<td></td>
<td>Individual tactics; offensive/defensive 1vs1 / 2vs1 / 2vs2 / 3vs3; keep ball in own rows</td>
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<tr>
<td></td>
<td>various contests in support of different techniques and tactics</td>
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<tr>
<td></td>
<td>- J+S Ordner Fussball</td>
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</table>

- Prerequisites / notice
  - 1. This course is leaded from Peter Humbel and Heinz Russheim together. For questions address Peter Humbel.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>557-0555-00L</td>
<td>Basketball II</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>R. Maggi</td>
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<tr>
<td></td>
<td>Prerequisite: Basic course completed</td>
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<tr>
<td>Abstract</td>
<td>Further development of the technical skills. Structural development of defensive behavior appropriate to the game situation. Introduction to the pre-tactical element of the pick away. Additionally the role and use of the inside players on offense and defense is looked at. In the center of attention during games stands the game management the combination of roles - teacher/coach/referee.</td>
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<td>Objective</td>
<td>- Further training of the individual basketball skills</td>
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<tr>
<td></td>
<td>- Participants know the tactical and technical aspects of the pick away</td>
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<tr>
<td></td>
<td>- Participants can make the right decisions in various defensive situations and with that make it more difficult for the offense.</td>
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<tr>
<td></td>
<td>- Leadership of a team during the game and during physical education class</td>
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<tr>
<td>Content</td>
<td>- Individual basics Passing/Footwork/Dribbling/Shooting</td>
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<tr>
<td></td>
<td>- Basics in the man-to-man defense on ball/off ball/stop the cut</td>
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<td></td>
<td>- Basics on offense getting open/cutting/scoring</td>
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<td></td>
<td>- Movement of the inside players</td>
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<td>- pick away</td>
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<td></td>
<td>- Game management in the classroom combination of roles teacher/coach/referee</td>
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<td>557-0545-00L</td>
<td>Volleyball II</td>
<td>2</td>
<td>W</td>
<td>J. Albrecht</td>
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<td></td>
<td>Prerequisite: Basic course completed</td>
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</tr>
<tr>
<td>Abstract</td>
<td>To learn the game of volleyball through the interaction between individual playing positions. To achieve skills in a six-a-side game without specialization. (system 3-2-1, setter pos. 1)</td>
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<tr>
<td>Objective</td>
<td>- To know the chain of action for each players position in the game</td>
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<tr>
<td></td>
<td>- To be able to play volleyball 6 against 6 without specialization (system 3-2-1, setter position 1)</td>
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<tr>
<td>Content</td>
<td>- basics, especially setting, block-defense</td>
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<tr>
<td></td>
<td>- individual tactics: chain of action, attack in all 3 net positions, setting from position 1, statistical evaluation of the game</td>
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<tr>
<td>Literature</td>
<td>- PAPAGEORGIOU/CZIMEK: &quot;Volleyball Spielerisch Lernen&quot;</td>
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<td>- PAPAGEORGIOU/SPITZLEY, &quot;Volleyball Grundlagenausbildung&quot;</td>
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<td>- PAPAGEORGIOU/SPITZLEY &quot;Leistungsvolleyball&quot;</td>
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<td>- PAOLINI M.: &quot;Volleyball from young player to champions&quot;</td>
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<td>- MEYNDT/BEUTELSTAHL: &quot;Richtig Volleyball - Halle und Beach&quot;</td>
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<td>557-0605-00L</td>
<td>Snowsport II</td>
<td>2</td>
<td>W</td>
<td>P. Disler, further lecturers</td>
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<td></td>
<td>Prerequisite: basic education Snowsport I completed.</td>
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<tr>
<td>Abstract</td>
<td>Specialization training: Acquisitions of special skills, getting to know the performance factors and training methods in the areas of Snowsports.</td>
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<tr>
<td>Objective</td>
<td>Snow sports (Skiing/Snowboarding):</td>
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<tr>
<td></td>
<td>- To deepen and expand experience and skills in snow sports and in the personal competency of technique of the chosen snow sport.</td>
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<td></td>
<td>- To expand skills to the area of telemark and competition</td>
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<tr>
<td>Content</td>
<td>Off-piste education:</td>
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<td></td>
<td>- To acquire knowledge and experience in planning and realization of back-country skiing and consider the environment</td>
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<tr>
<td>Literature</td>
<td>- PAPAGEORGIOU/CZIMEK: &quot;Volleyball Spielerisch Lernen&quot;</td>
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<td>- PAOLINI M.: &quot;Volleyball from young player to champions&quot;</td>
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<td>557-0426-00L</td>
<td>Fitness II</td>
<td>2</td>
<td>W</td>
<td>C. Romano, A. Sonderregger</td>
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<td>Prerequisites: successful completion of Basic Education in Fitness.</td>
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<tr>
<td>Abstract</td>
<td>A consolidation of fitness education; relevant performance factors in the training of physical fitness. Acquisition of skills, tactics, methodology in the areas of fitness and aerobics. Getting to know current and prophylactic training aspects and the training thereof.</td>
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<tr>
<td>Objective</td>
<td>To deepen knowledge of relevant components of physical fitness</td>
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<td></td>
<td>To get to know and to enhance knowledge of actual preventative aspects of fitness training</td>
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<td>Content</td>
<td>- Fittests im Fitnessbereich</td>
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<td>- Krafttrainings- und Ausdauergeräte</td>
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<td>- Trainingsprogramme im Fitnessbereich für Kraft, Ausdauer und Beweglichkeit</td>
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<td>- Programmmanpassungen bei Problemen am Bewegungsapparat</td>
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<td>- Einführung von Personen an Fitnessgeräten</td>
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<td>- Funktionelle Anatomiekennnisse im Fitnessbereich</td>
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<td>- Aerobics: Aufbau und Einführung von Aerobicblöcken</td>
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<td>Literature</td>
<td>- Skript GA Fitness, GA+VA Gymnastik und Haltung</td>
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<td></td>
<td>- Taschenatlas der Anatomie, Bewegungsapparat, W.Platzer, Thieme Verlag</td>
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<td>- Optimales Training, J.Weineck, Erlangen, Spitta Verlag</td>
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<td>- Training fundiert erklärt, Jost Hegner, Ingold Verlag</td>
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<td>Requirement: Basic course in Snowsport I completed.</td>
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| 557-0434-01L | Acrobatics II           | 2       | W      | B. Matti Baur, M. M. Jaeggi |
|              | Prerequisites: successful completion of Basic Education. |
| Abstract     | To get to know and understand the basics of movement (core movements) and its respective actions and functions on the floor, in acrobatics and partner acrobatics as well as in Parkour to create individual and cooperative combinations according to qualitative criteria. |
| Objective    | The students should be able to: |
|              | - acquire and consolidate core movements as well as to apply and create such combinations |
|              | - utilize their own strength as well as the resulting impact in a differentiate way in order to precisely and economically move the swinging, flying, falling and twisting body |
|              | - gain orientation safety and room orientation while twisting and flying |
|              | - gain sensitivity for social competences (e.g. to assist, to observe, to advise) within a small group |
|              | - compose and present within a group of three a creative performance |
### Education Acquired Outside ETH

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tr>
<td>557-0450-00L</td>
<td>Life Saving Rescue Test Plus Pool SLRG&lt;br/&gt;Only for Sport Teaching Diploma students.&lt;br/&gt;Confirmation of course attendance Brevet Basis Pool and Brevet Plus Pool SLRG.</td>
<td>O</td>
<td>2 credits</td>
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<td>external organisers</td>
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<tr>
<td>557-0451-00L</td>
<td>Samariterausweis&lt;br/&gt;Only for Sport Teaching Diploma students.&lt;br/&gt;Confirmation of course attendance “Samariterausweis”. More information: <a href="http://www.samariter.ch">www.samariter.ch</a>.</td>
<td>O</td>
<td>2 credits</td>
<td></td>
<td>external organisers</td>
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</table>

**Abstract**
- To recognize danger in, on and around water
- Knowledge and handling of lifesaving equipment
- Rescue and towing techniques
- Orientation under water
- To rescue a person
- Basis knowledge in anatomy and first aid

**Objective**
- To be able to judge an injured person and to apply life-saving actions
- To carry out wound treatment with actual bandage
- To list the characteristics of a sprain, strain, dislocation and to apply first-aid interventions
- To carry out fixed bandages with common material
- To explain the function of the cardiovascular system
- To name the symptoms of poisoning
- To list the signs of acute illness
- To put together the content of a first-aid box
- To carry out safety interventions in daily situations.

**Content**
- Hautverletzungen
- Wundinfektion / Blutvergiftung
- Stürze im Alltag (Verstauchungen, Prellungen, Quetschungen)
- Sportverletzungen, Knochenbrüche
- Herz Kreislaufstörungen
- Alltagserkrankungen in der Familie

**Prerequisites / notice**
- Fremdausbildung; Dauer 7x2h

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**Sport Teaching Diploma - Key for Type**

<table>
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<th>W+</th>
<th>Eligible for credits and recommended</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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<td>Courses outside the curriculum</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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**Key for Hours**

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<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</table>

**ECTS**
- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In order to achieve this goal, legal problems and issues will be presented to the participants and then discussed in class.

In the second part of the course, the focus is on different legal issues, such as liability, contract performance, property rights, and the relationship between law and society. Students attending this course and passing the required tests (one in the middle, the other at the end of the semester) will obtain 4 ECTS credit points.

The course ‘Introduction au Droit civil’ (851-0709-00) provides an introduction to the law of Contracts and Torts in French.
Examine the fundamentals of the two sciences and establish links with military life. Discuss various schools of thought in psychology and economics as a science, division of labour and welfare (concept of comparative advantage), supply and demand (market equilibrium, elasticity), households (preferences, demand), firms (technology, cost analysis, profit maximisation, supply), perfect competition, monopoly and oligopoly, externalities, public goods, information, factor markets and income distribution.

Mandatory and further reading will be made available at https://ilias-app2.let.ethz.ch/goto.php?target=crs_85655&client_id=ilias_lda.

This course is completely by a compulsory one week course between terms.

The lecture is supported by a virtual learning environment containing relevant documents (presentations and texts) and information to further literature.

**Remainig Core Courses of the Bachelor Programme**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>853-0205-00L</td>
<td>Proseminar I: Political Methodology</td>
<td>O</td>
<td>3 credits</td>
<td>2S</td>
<td>R. Huber</td>
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<tr>
<td>853-0064-00L</td>
<td>Military Sociology I</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>T. Szvircsev Tresch</td>
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</tbody>
</table>

**Prerequisites / notice**

1) Source analysis and acquisition: based upon a research question that will be given by the lecturer, the student shall collect a comprehensive list of the relevant literature and summarize that with her/his own words.

2) Critical analysis of sources: based upon a research article that the student chooses on her/his own, the student shall write a critical analysis of that, which mirrors frame and structure of scientific writing.
Abstract
Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.

Objective
Recognize and explain current changes (social change) in modern society (individualisation, pluralisation); describe demographic changes in Switzerland; explain the structures of societies; define issues and fields of research in modern military sociology and explain the foundations of organisational sociology; explain the military in terms of organisational sociology and identify specific traits of the military as an organisation.

Content
Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.

Literature
A reader with a set of texts will be handed out.

Languages
First Foreign Language

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<th>Number</th>
<th>Title</th>
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<tr>
<td>853-0405-00L</td>
<td>English, Part I Only for Public Policy BA</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>O. Gwerder</td>
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</table>

Abstract
Teaching is focused on the acquisition of general English in the four classical skills, i.e. speaking, listening comprehension, reading comprehension and writing. The goal is to reach level B2 or C1 depending on the linguistic proficiency of the students.

Objective
This three-semester English course should enable the participants to successfully use the English language in an international military setting.

Content
Read, analyse and write military and civilian documents
Listening comprehension using current radio or TV reports
Practise speaking through group discussions and short presentations
Systematic revision and extension of key grammar points
Systematic acquisition of general and military vocabulary

3. Semester

Remaining Core Courses of the Bachelor Programme

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<th>Number</th>
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<th>Type</th>
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<tr>
<td>853-0015-00L</td>
<td>Conflict Research I: Causes of War in Historical Context</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>L.E. Cederman</td>
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</tbody>
</table>

Abstract
This course offers an introduction to research on causes of wars. War as a social phenomenon is covered from the pre-state world to today's state system after the end of the Cold War. Topics include state formation and collapse, nationalism, decolonization, democracy, and ethnic conflict.

Objective
Developing an understanding for causes of war and their development over the last 500 years. Knowledge of fundamental concepts in research on causes of war.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<td>853-0046-00L</td>
<td>Social Psychology of Groups</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>T. Heilmann</td>
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</tbody>
</table>

Abstract
Relevant applied social psychosocial topics will be discussed.
You have got the chance

1. To learn about basic fields of social psychology.
2. To apply the lessons learned to your own (military) situation/daily life.
3. To think about daily social psychological pitfalls
4. To connect theory and application based on case studies.

Objective
You will work on the following topics:

Social perception: How do we perceive humans? And how do we do attributions of human behavior?
Social Cognition: Why and on what basis do we make social judgments?
Social Influence: Which facets of influence do exist? How come? What are the implications of social influence in a group?
Group psychology: What is a group? What happens if someone enters into a group? How do groups develop? What are the processes?
Prejudice in groups: What can we do about prejudice and conflicts between groups?
Applied social psychology: Insights in leadership psychology.

Literature

Prerequisites / notice
Lehrspann im Studiengang Berufssozialer

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>853-0047-00L</td>
<td>World Politics Since 1945: The History of International Relations</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>A. Wenger</td>
</tr>
</tbody>
</table>

Abstract
This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

Objective
By the end of the semester, participants of the lecture should have a solid knowledge on the history and theoretical foundations of International Relations since the end of the Second World War.

Content
cf. “Diploma Supplement”

Literature
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Type</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0065-00L</td>
<td>Business Administration I</td>
<td>O</td>
<td>4 credits</td>
<td>For Public Policy BA</td>
</tr>
<tr>
<td>853-0063-00L</td>
<td>Military History I (with Exercises)</td>
<td>O</td>
<td>4 credits</td>
<td>For Public Policy BA</td>
</tr>
<tr>
<td>853-0082-00L</td>
<td>Strategic Studies I</td>
<td>O</td>
<td>3 credits</td>
<td>For Public Policy BA</td>
</tr>
<tr>
<td>853-0302-00L</td>
<td>European Integration: Seminar</td>
<td>O</td>
<td>4 credits</td>
<td>For Public Policy BA</td>
</tr>
</tbody>
</table>

**Business Administration I**
- **Objective**: Develop corporate finance thinking, record transactions and prepare financial statements, master tools and methods used for financial management.
- **Content**:
  - Financial Accounting
  - Accounts
  - Balance sheet and income statement
  - Inventories
  - Value-added tax, prepayments and accruals
  - Provisions, depreciation
  - Evaluation, hidden reserves
  - Financial planning
  - Cash budget
  - Capital budgeting

**Military History I (with Exercises)**
- **Objective**: Distinguish between military history as a subject and historiography as a way of describing events; analyse the modern developments regarding armed forces and warfare in the context of socio-economic changes; based on the approach regarding revolution in military affairs, describe the evolution of the armed forces and of warfare; exemplify the issues regarding the evolution of the combat (First and Second World War, Vietnam War and Algerian War).
- **Content**: The lecture outlines the development of the armed forces (assets regarding manpower, technology and armament), the concepts of warfare and the actual warfare in the 19th and 20th century. Special emphasis will be put on how the battlefield was revolutionized due to the Napoleonic wars, the industrialization in the 19th century, the First World War, the mechanization and totalization during the Second World War and the period of the Cold War.

**Strategic Studies I**
- **Objective**: The participants know the classical conceptions of strategy and war theory from antiquity to the present against their specific background. They recognize aspects, which are useful for the understanding of modern/current conflicts. They are capable of analyzing critically original texts and modern scholarly works in the field of strategic studies.
- **Content**: The lecture series introduces the basic concepts of strategy and war theory and wants to present the variety of asymmetric warfare throughout history. It critically highlights in particular Sun Tzu, Machiavelli, Jomini, Clausewitz, Moltke, Mahan, Corbett, Douhet, Fuller, Liddell Hart, Swetchnin, Tuchatschevsky, Mao and Che Guevara, etc. (see program). If appropriate, a specific Swiss view is being applied.

**European Integration: Seminar**
- **Objective**: The seminar covers the theory, development, and core policy fields of European integration as well as structures and processes of the EU as a decision- and policy-making system.

**Prerequisites / notice**: The lecture is being supported by a virtual classroom. If you have any questions, please contact Lukas Meyer; lukas.meyer@ispo.gess.ethz.ch.
Participants should gain a solid understanding of current issues in international security policy as well as of the central academic debates. Students are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle.

ECTS

Title: English, Part III
Lecturers: O. Gwerder

Type: W
ECTS: 3 credits
Hours: 2G
Lecturers: O. Gwerder

Abstract: The knowledge and skills acquired in the second semester serve as a basis for further speaking in the areas of speaking, listening, reading and writing, which will enable students to enroll for the Cambridge exams. The goal is to reach Council of Europe (CEFR) level C1 or C2 depending on the linguistic proficiency of the students.

Objective: This three-semester English course should enable the participants to successfully use the English language in an international military setting.

Content: 
- Read, analyse and write military and civilian documents
- Listening comprehension using current radio or TV reports
- Practise speaking with group discussions and short presentations
- Systematic revision and extension of key grammar points
- Systematic acquisition of general and military vocabulary

5. Semester

Remaining Core Courses of the Bachelor Programme

Title: Introduction to Constitutional Law in Security Policy
Lecturers: P. Sutter

Type: O
ECTS: 3 credits
Hours: 2V
Lecturers: P. Sutter

Abstract: This introduction into the constitutional elements of security policy includes questions of competences (separation of powers, federalism) and considerations on the constitutional mandates and powers of military, police and private agents - especially in the state of emergency.

Objective: Students should:
- know the basic terms of security law;
- understand the actors of security policy and their position within the constitutional order;
- know the constitutional mandate and powers of the military and the police;
- know the elements of cooperation between military and police;
- know the constitutional rules to deal with a state of emergency;
- know the legal status of members of the military forces;
- know any persons rights of judicial review of security measures.

Content: The legal status of individuals (members of the military forces; persons involved in security measures) is ventilated.

Lecture notes: Reader with copies of the relevant literature (see below) https://moodle-app2.let.ethz.ch/course/view.php?id=203

Literature: The basic sources of the lectures are:
- Patrick Sutter, Recht der militärischen Operationen, Sicherheit & Recht 1/2008, S. 19-32

These articles and further sources are part of the Reader mentioned above.

Title: Current Issues in Security Policy
Lecturers: A. Wenger, O. Thränert

Type: O
ECTS: 3 credits
Hours: 2V
Lecturers: A. Wenger, O. Thränert

Abstract: This course provides an overview of the developments in the international system and the central security challenges since the end of the Cold War. The focus of this course will be on security issues of the post 9/11 era: new risks, arcs of crises, security strategies and core actors will be presented during the course.

Objective: Participants should gain a solid understanding of current issues in international security policy as well as of the central academic debates.

Content: The aim of the course is to provide the participants with an overview of international security politics in a globalized world. After dealing with the major changes of the international security environment as compared to the cold war era, we will concentrate on some of the key challenges (international terrorism, proliferation of weapons of mass destruction etc.). The third part of the lecture focuses on security strategies pursued by the 'Western' world.

Lecture notes: A reading list will be distributed at the beginning of the spring semester.

Literature: An online learning platform serves as a supplement to the lecture course.

Title: Swiss Foreign Policy
Lecturers: D. Möckli

Type: O
ECTS: 3 credits
Hours: 2V
Lecturers: D. Möckli

Abstract: This course provides an overview of the development of the international system and the central security challenges since the end of the Cold War. The focus of this course will be on security issues of the post 9/11 era: new risks, arcs of crises, security strategies and core actors will be presented during the course.

Objective: Participants should gain a solid understanding of current issues in international security policy as well as of the central academic debates.

Content: The aim of the course is to provide the participants with an overview of international security politics in a globalized world. After dealing with the major changes of the international security environment as compared to the cold war era, we will concentrate on some of the key challenges (international terrorism, proliferation of weapons of mass destruction etc.). The third part of the lecture focuses on security strategies pursued by the 'Western' world.

Lecture notes: A reading list will be distributed at the beginning of the spring semester.

Literature: An online learning platform serves as a supplement to the lecture course.
Students should acquire a sound understanding of Swiss foreign policy and the relevant academic and political debates associated with it.

Read, analyse and write military and civilian documents

German, Part II

This course analyzes the foundations and central challenges of Swiss foreign policy. After reviewing the history of foreign and neutrality policy conceptions since the early 20th century, the determining factors of Swiss foreign policy will be discussed, and issues such as the Ukraine crisis, Swiss-EU relations, and Switzerland and the Middle East will be examined.

After introducing the field of Foreign Policy Analysis, this course will first deal with the historical foundations and the conceptual development of Swiss foreign policy. The focus will be on Switzerland’s different reactions to the new international orders after 1918, 1945, and 1989 as well as on the significance of the 9/11 terrorist attacks and the global financial and debt crises since 2009 for Swiss foreign policy. We will also discuss the extent to which the Ukraine crisis and the annexation of Crimea by Russia mark a watershed in the international order - and how Switzerland should respond to these challenges.

Subsequently, key determinants of Swiss foreign policy will be analyzed, with specific attention on neutrality, direct democracy, and the special case paradigm. Finally, the discussion will center on current challenges and issues such as Swiss-EU relations, the Ukraine crisis and the OSCE engagement, Switzerland’s role in the UN, Swiss peacebuilding efforts, Swiss policy in the Middle East, and development cooperation.

The first hour will consist of a lecture; in the second hour, we will deepen and discuss the respective issues together with guest speakers from the Swiss foreign ministry, including Secretary of State Rossier.

Students will receive a handout of slides accompanying the lectures.

A reading list will be handed out at the beginning of the semester.

The course will be supported by an e-learning environment.

A Reader was provided as part of seminar I (cf. online platform Moodle).

The necessary literature can be downloaded from "Moodle".

Languages

Second Foreign Language

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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>853-0402-00L</td>
<td>German, Part II</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>O. Gwerder</td>
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<tr>
<td></td>
<td>Only for Public Policy BA</td>
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<tr>
<td>Abstract</td>
<td>Based on the knowledge and skills acquired during the first semester, speaking and discussion skills related to military situations are examined and put into practice. Attention is focused on issues such as instruction, qualification and career interviews.</td>
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<tr>
<td>Objective</td>
<td>This two-semester German course should enable the French and Italian speaking participants to fulfill their function as professional officers also in the German language.</td>
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<tr>
<td>Content</td>
<td>Read, analyse and write military and civilian documents</td>
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<td></td>
<td>Practise speaking with group discussions and short presentations</td>
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<tr>
<td>Objective</td>
<td>This two-semester French course should enable the German speaking participants to fulfill their function as professional officers also in the French language.</td>
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<tr>
<td>Content</td>
<td>Read, analyse and write military and civilian documents</td>
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Bachelor Colloquium and Bachelor Thesis

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<td>BA Colloquium</td>
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<td>A. Wenger, M. Dunn Cavelty</td>
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Languages

Second Foreign Language

English - Part I

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<tr>
<td>853-0402-00L</td>
<td>German, Part II</td>
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Bachelor Colloquium and Bachelor Thesis

<table>
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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>853-0315-00L</td>
<td>BA Colloquium</td>
<td>O</td>
<td>2</td>
<td>2K</td>
<td>A. Wenger, M. Dunn Cavelty</td>
</tr>
</tbody>
</table>

The BA Colloquium prepares students for their BA thesis with regard to content, administration, and methodology. During the colloquium, students choose a topic and a supervisor for their thesis. The skills students have acquired during the course of their studies are also enhanced and optimized.

The students are being prepared administratively and methodologically to write their BA-thesis after completing the course.

The BA Colloquium prepares students for their BA thesis with regard to content, administration, and methodology. During the colloquium, each student has to choose a topic for his/her BA-thesis. The students also choose their supervisors, whereas the goal is an even distribution of the supervisors. Finally, the methodological competences which were acquired during the first four semesters will be complemented.

If you have questions, please contact Prof. A. Wenger, wenger@sipo.gess.ethz.ch, 044 632 59 10.

**Electives**

**Recommended Elective Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<tr>
<td>853-0564-00L</td>
<td>Bachelor's Thesis</td>
<td>O</td>
<td>10</td>
<td>8D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
The Bachelor Thesis completes the Bachelor program and consists of a scientific project carried out independently under the tutelage of an ETH or MILAK lecturer in Public Policy.

Objective
The elaboration of the Bachelor Thesis should further students' capacities to work independently, structured and scientifically.

**Additional Elective Courses**

* These Electives may be chosen from the start of the Bachelor Study Programme.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>853-0102-00L</td>
<td>Military Business Administration II - Case Examples</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. M. Keupp</td>
</tr>
</tbody>
</table>

Abstract
The elective course Military Business Administration II builds on the mandatory course Military Business Administration I and adds to it. It deals with in-depth case studies from international security and economic policy with a special emphasis on the economic and practical relevance of these issues for the Swiss Armed Forces.

Objective
Students who are intrinsically interested in business-related issues will be provided with a big picture that transcends the micro view of business administration. Students learn how to integrate security and resource-related issues into a global economic analysis and how to derive relevant consequences, particularly economic ones, for Switzerland.

Content
The program of the course is organized into 14 units of 90 minutes each. The units combine the elements of lecture (where analytical concepts are taught) and application (where these concepts are applied). Additionally, guest lecturers will hold talks on selected issues.

- Swiss economic autarchy - madness or option?
- Global resource positions and world trade: Implications for the Swiss Armed Forces I
- Global resource positions and world trade: Implications for the Swiss Armed Forces II
- Economic causes of military instability
- Aggressive emerging economies: Economic growth and rearmament
- The process of an arms deal
- Costs and financing of a military conflict
- Economic analysis of terrorism
- Economic analysis of cyberwar
- Economic analysis of the present GSOA initiative: Compulsory military service vs. voluntary militia
- Global arms production and international arms trade
- The privatisation of military security
- Standardisation and interoperability: Does NATO membership increase Swiss military efficiency
- Written exam

Lecture notes
As this course has been completely redesigned and is being offered for the first time in the fall semester of 2013, a script is not yet available. However, the lecturer will distribute all necessary course material in time and directly to the students, either in the classroom or by uploading files to a public server.

Literature
The Lecturer will distribute all necessary literature directly to the students by disseminating pdf files or citing links to online references.

Prerequisites / notice
Exam "Military Business Administration I" passed successfully or profound basic knowledge of business administration and economics. The course is open to external participants.

<table>
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<tr>
<th>Number</th>
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<th>Type</th>
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<tr>
<td>376-1033-00L</td>
<td>History of Sports</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Gisler</td>
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</tbody>
</table>

Abstract
Comprehension for development and changes of sports from the ancient world to the present. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Objective
Understanding for the development and adaptation of sports from the ancient world to present times.

Content

Lecture notes
Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tr>
<td>376-1107-00L</td>
<td>Sport Pedagogy</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>D. Seiler Hubler</td>
</tr>
</tbody>
</table>

Abstract
Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

Objective
To gain basic knowledge of sport pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Content
Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik
- Bedeutung des Sports im Kindes- und Jugendalter
- Leistungssport im Kindes- und Jugendalter
- Pädagogische Perspektiven des Sportunterrichts in der Schule
- Ein zeitgemäßer Schulsport
- Bewegungskulturelle Bildung: Bewegungserziehung, Spielerziehung

Lecture notes
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

<table>
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<tr>
<th>Number</th>
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<tr>
<td>376-1117-00L</td>
<td>Sport Psychology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>H. Gubelmann</td>
</tr>
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</table>

Abstract
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.
### WebClass Introductory Course History of Technology

**Objective**
- Students are given insight into different work areas of sport psychology. In order to understand what "sport psychology" is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students’ expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

**Content**
- Main Topics
  - Introduction to sport psychology
  - Cognitions in sports: mental rehearsal and mental training
  - Emotions and stress
  - Motivation: goal-setting in sports
  - Career and career transition in elite sport
  - Coach-Athlete-Interaction
  - Psychological aspects of sport-injury rehabilitation
  - Group dynamics in sport

**Literature**
- D. Gugerli

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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<th>Credits</th>
<th>V</th>
<th>Lecturer</th>
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<tbody>
<tr>
<td>376-1127-00L</td>
<td>Sociology of Sport</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Lamprecht</td>
</tr>
<tr>
<td>851-0549-00L</td>
<td>WebClass Introductory Course History of Technology</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>D. Gugerli</td>
</tr>
<tr>
<td>851-0589-00L</td>
<td>Technology and Innovation for Development</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>P. Aerni</td>
</tr>
</tbody>
</table>

**Abstract**

**Objective**
- To recognize the challenges and opportunities of technological change in terms of sustainable development
- To become familiar with policy instruments to promote innovation
- To improve understanding of political decision-making processes in the regulation of science & technology
- Improved understanding of the role of science and technology in the context of human and societal development

**Content**
- The economy and the media: dependencies, consequences, scandals
- Social inequities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

**Literature**

A detailed program with additional references will be delivered at the beginning of the lecture.
Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies. The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g., environmental regulations, anti-trust law) or facilitate (e.g., intellectual property rights protection, public investment in R&D and technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Prerequisites / notice

The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester. The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

International Environmental Politics

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient. The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems. The course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences. After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Lecture notes

Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your Netflux username and password to access the material.

Literature


The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.
Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The workload for this course is approx. 120 hours (all inclusive).

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>Students: P. Baschera, M. Kersting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The content of the course will rely on the book:</td>
</tr>
<tr>
<td></td>
<td>A comprehensive script will be made available online on the moodle platform.</td>
</tr>
<tr>
<td></td>
<td>Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.</td>
</tr>
<tr>
<td></td>
<td>Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.</td>
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</table>

<table>
<thead>
<tr>
<th>701-0763-00L</th>
<th>Basic Concepts of Management</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>R. Schwarzenbach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Students: will be familiar with general management concepts.</td>
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<td></td>
<td>will learn about the fundamental concepts of strategy development with practical examples.</td>
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<td></td>
<td>will get to know the basic organisational issues and the essential types of organisations.</td>
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<td></td>
<td>get a rough overview on the concepts of financial management.</td>
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<td></td>
<td>will learn about the strategic positioning of small departments within larger organisations.</td>
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<td></td>
<td>will learn about the fundamental mechanisms for handling change, and will be able to recognise these situations.</td>
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<td></td>
<td>will learn the basic principles of project management and of successful self-management.</td>
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<td></td>
<td>will reflect on customer oriented information representation.</td>
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<tr>
<td>Abstract</td>
<td>This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts.</td>
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<tr>
<td>Notes</td>
<td>Skripten werden elektronisch zur Verfügung gestellt.</td>
<td></td>
<td></td>
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<tr>
<td>Literature</td>
<td>Empfohlen werden folgende Titel für die Vertiefung einzelner Themen:</td>
<td></td>
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<table>
<thead>
<tr>
<th>363-0341-00L</th>
<th>Introduction to Management</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>S. Brusoni, P. Baschera, N. Rosenkranz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>We develop a 'systemic' view of organizations.</td>
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<td></td>
<td>We look at organizations as part of an industry context, which is affected by different elements like strategy, structure, culture, tasks, people and outputs.</td>
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<tr>
<td></td>
<td>We consider how managerial decisions are made in any one of these domains affect decisions in each of the others.</td>
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<tr>
<td>Abstract</td>
<td>This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization.</td>
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<tr>
<td>Notes</td>
<td>Skripten werden elektronisch zur Verfügung gestellt.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Empfohlen werden folgende Titel für die Vertiefung einzelner Themen:</td>
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<table>
<thead>
<tr>
<th>851-0735-10L</th>
<th>Business Law</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>P. Peyrot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.</td>
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<tr>
<td>Notes</td>
<td>Project adequately suitable for students of D-ITET</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>101-0515-00L</th>
<th>Project Management</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>M. Kersting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>To introduce the methods and tools of project management. To impart knowledge in the areas of project organisation and structure, project planning, resource management, project controlling and on team leadership and team work.</td>
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</tbody>
</table>

The content of the course will rely on the book:

- Selected readings from the book and additional learning materials will be available on the course Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=1287

All the materials uploaded on Moodle must be considered as required readings.
## Complexity and Global Systems Science

**Code:** 851-0585-15L  
**Weight:** 3 credits  
**V:** 2  
**Lecturers:** D. Helbing, L. Sanders

### Abstract
This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

### Objective
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

### Content
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at "tipping points", multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or "tragedies of the commons" such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.

### Prerequisites / notice
Mathematical skills can be helpful.
Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

Content
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
The script and lecture material are provided at:
https://moodle-app2.let.ethz.ch/course/view.php?id=140

Literature
Für die Kreditvergabe sind die vorgeschriebenen Semesterarbeiten und die Präsenz zwingend. Die Benotung erfolgt durch eine schriftliche Arbeit.

**Planung**

Die Planungsunterlagen werden zu Semesterbeginn abgegebenen, sind provisorisch und können vom Dozenten geändert werden. Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.

Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.


---

### Public Policy Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Core Courses

In each subject area, the core courses offered are normally mathematical as well as application-oriented in content. For each subject area, only one of these is recognised for the Master degree.

Regression

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>M. Dettling</td>
</tr>
</tbody>
</table>

Abstract

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student's own projects and daily work life.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content

The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Analysis of Variance and Design of Experiments

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

Abstract

Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content


Multivariate Statistics

No course offerings in this semester.

Time Series and Stochastic Processes

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-4623-00L</td>
<td>Time Series Analysis</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>not available</td>
</tr>
</tbody>
</table>

Abstract

Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective

Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content

This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Mathematical Statistics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3621-00L</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>W</td>
<td>10</td>
<td>4V+1U</td>
<td>S. van de Geer</td>
</tr>
</tbody>
</table>
Abstract
The course covers the basics of inferential statistics.

401-8623-00L Likelihood Inference (University of Zurich) W 5 credits 3G University lecturers
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: STA402
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Overview over the basics of likelihood inference.

► Specialization Areas and Electives

>>> Statistical and Mathematical Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3601-00L</td>
<td>Probability Theory</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>A.S. Sznitman</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basics of probability theory and the theory of stochastic processes in discrete time</td>
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<tr>
<td>Objective</td>
<td>This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<tr>
<td>Content</td>
<td>This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<td></td>
<td>H. Bauer, Probability Theory, de Gruyter 1996</td>
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<td></td>
<td>J. Jacod and P. Protter, Probability essentials, Springer 2004</td>
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<td></td>
<td>A. Klenke, Wahrscheinlichkeitsrechnung, Springer 2006</td>
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<td></td>
<td>D. Williams, Probability with martingales, Cambridge University Press 1991</td>
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<tr>
<td>Lecture notes</td>
<td>available, will be sold in the course</td>
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<tr>
<td>401-3627-00L</td>
<td>High-Dimensional Statistics</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>P. L. Bühlmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>&quot;High-Dimensional Statistics&quot; deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of methods and basic theory for high-dimensional statistical inference</td>
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<tr>
<td>Content</td>
<td>Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).</td>
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<tr>
<td>401-3611-00L</td>
<td>Advanced Topics in Computational Statistics</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>M. H. Maathuis, M. Mächler</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.</td>
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<tr>
<td>Objective</td>
<td>Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.</td>
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<tr>
<td>Content</td>
<td>The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes</td>
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<tr>
<td>Prerequisites / notice</td>
<td>We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.</td>
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<tr>
<td>401-4633-00L</td>
<td>Data Analytics in Organisations and Business</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>I. Flückiger</td>
</tr>
<tr>
<td>Abstract</td>
<td>On the end-to-end process of data analytics in organisations &amp; business and how to transform data into insights for fact based decisions. Presentation of the process from the beginning with framing the business problem to presenting the results and making decisions by the use of data analytics. For each topic case studies from the financial service, healthcare and retail sectors will be presented.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to give the students the understanding of the data analytics process in the business world, with special focus on the skills and techniques used besides the technical skills. The student will become familiar with the &quot;business language&quot;, current problems and thinking in organisations and business and tools used.</td>
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<tr>
<td>Content</td>
<td>Framing the Business Problem</td>
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<td></td>
<td>Framing the Analytics Problem</td>
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<tr>
<td></td>
<td>Data Methodology</td>
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<tr>
<td></td>
<td>Model Building</td>
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<tr>
<td></td>
<td>Deployment</td>
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<tr>
<td></td>
<td>Model Lifecycle</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture Notes will be available.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Basic statistics and probability theory and regression</td>
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<tr>
<td>401-6217-00L</td>
<td>Using R for Data Analysis and Graphics (Part II)</td>
<td>W</td>
<td>1 credit</td>
<td>1G</td>
<td>A. J. Papritz, C. B. Schwierz</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides the second part an introduction to the statistical software R for scientists. Topics are data generation and selection, graphical functions, important statistical functions, types of objects, models, programming and writing functions. Note: This part builds on &quot;Using R... (Part I)&quot;, but can be taken independently if the basics of R are already known.</td>
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<tr>
<td>Objective</td>
<td>The students will be able to use the software R efficiently for data analysis.</td>
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</tbody>
</table>
This course covers several generally useful statistical methods:
- Nonparametric tests, randomization tests, jackknife and bootstrap, as well as asymptotic approximations and robustness properties of estimators.
- Elements of the R language: control structures (if, else, loops), lists, overview of R objects, attributes of R objects;
- More on R functions;
- Applying functions to elements of vectors, matrices and lists;
- Object oriented programming with R: classes and methods;
- Tayloring R: options;
- Extending basic R: packages.

References:
The course provides the second part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

401-0627-00L Smoothing and Nonparametric Regression with Examples

Abstract
Starting with an overview of selected results from parametric inference, kernel smoothing (including local polynomials) will be introduced along with some asymptotic theory, optimal bandwidth selection, data driven algorithms and some special topics. Examples from environmental research will be used for motivation, but the methods will also be applicable elsewhere.

Objective
The students will learn about methods of kernel smoothing and application of concepts to data. The aim will be to build sufficient interest in the topic and intuition as well as the ability to implement the methods to various different datasets.

Content
- Parametric estimation methods: selection of important results
  - Maximum likelihood
  - Least squares: regression & diagnostics
- Nonparametric curve estimation
  - Density estimation, Kernel regression, Local polynomials, Bandwidth selection
  - Selection of special topics (as time permits, we will cover as many topics as possible) such as change points, modes & monotonicity, robustness, partial linear models, roughness penalty, local likelihoods, etc.
- Applications: potential areas of application such as, change assessment, trend and surface estimation, probability and quantile curve estimation, and others.

Lecture notes
Brief summaries or outlines of some of the lecture material will be posted at http://www.wsl.ch/info/mitarbeitende/ghosh/index_EN (click on "ETH Course" in the left panel).

Prerequisites / notice
Additional references will be given out in the lectures.

401-6201-00L Resampling Methods

Abstract
Special Students "University of Zurich (UZH)" in the Master Program in Biostatistics at UZH cannot register for this course unit electronically. Forward the lecturer's written permission to attend to the Registrar's Office. Alternatively, the lecturer may also send an email directly to kanzle@rektorat.ethz.ch. The Registrar's Office will then register you for the course.

Objective
This course covers several generally useful statistical methods:
- Nonparametric tests, randomization tests, jackknife and bootstrap, as well as asymptotic approximations and robustness properties of estimators.
- For the classical parametric models there are optimal statistical estimators and test statistics, and their distributions can often be determined exactly. The methods covered in this course allow for finding statistical procedures for more general models and to derive exact or approximate distributions of complicated estimators and test statistics. They thus make it possible to use specific models for any applications under consideration and to derive corresponding statistical procedures.

Content
- Nonparametric tests, randomization tests, jackknife and bootstrap, asymptotic approximations and robustness properties of estimators.

Lecture notes
http://stat.ethz.ch/~meier/teaching/resampling/
Many scientific and commercial applications require us to obtain insights from massive, high-dimensional data sets. In this graduate-level course, we will study principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course both covers theoretical foundations and practical applications.

Prerequisites:
- Solid basic knowledge in statistics, algorithms and programming.
- Background in machine learning is helpful but not required.

Content:
- Many scientific and commercial applications require insights from massive, high-dimensional data sets. This course introduces principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course both covers theoretical foundations and practical applications.

Abstract:
This course focuses on nonparametric estimation of probability densities and regression functions. These recent methods allow modelling without restrictive assumptions such as 'linear function'. These smoothing methods require a weight function and a smoothing parameter. Focus is on one dimension, higher dimensions and samples of curves are treated briefly. Exercises at the computer.

Objective:
Knowledge on estimation of probability densities and regression functions via various statistical methods.

Literature:
"Data Mining" is a large field from which in this block course, we only treat so called prediction problems, aka "supervised learning".

Part 1, Classification, recalls logistic regression and linear / quadratic discriminant analysis (LDA/QDA) and extends these (in the framework of "Bayes classifier") to (generalized) additive (GAM) and tree models (CART), and further mentions other flexible ("nonparametric") methods.

Part 2, Flexible Prediction (of continuous or "class" response/target) contains additive models, MARS, Y-Transformation models (ACE, AVAS); Projection Pursuit Regression (PPR), neural nets.

The block course is based on (German language) lecture notes. The exercises are done exclusively with the (free, open source) software "R" (http://www.r-project.org). A final exam will also happen at the computers, using R (and your brains!).

<table>
<thead>
<tr>
<th>Content</th>
<th>Prerequisites / notice</th>
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</thead>
<tbody>
<tr>
<td>Special Students &quot;University of Zurich (UZH)&quot; in the Master Program in Biostatistics at UZH cannot register for this course unit electronically. Forward the lecturer's written permission to attend to the Registrar's Office. Alternatively, the lecturer may also send an email directly to <a href="mailto:kanzlei@rektorat.ethz.ch">kanzlei@rektorat.ethz.ch</a>. The Registrar's Office will then register you for the course.</td>
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<table>
<thead>
<tr>
<th>401-6289-00L Sampling Surveys</th>
<th>W</th>
<th>2 credits</th>
<th>1G</th>
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</thead>
<tbody>
<tr>
<td>Special Students &quot;University of Zurich (UZH)&quot; in the Master Program in Biostatistics at UZH cannot register for this course unit electronically. Forward the lecturer's written permission to attend to the Registrar's Office. Alternatively, the lecturer may also send an email directly to <a href="mailto:kanzlei@rektorat.ethz.ch">kanzlei@rektorat.ethz.ch</a>. The Registrar's Office will then register you for the course.</td>
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<thead>
<tr>
<th>401-6273-00L Bayes Methods</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
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</thead>
<tbody>
<tr>
<td>Special Students &quot;University of Zurich (UZH)&quot; in the Master Program in Biostatistics at UZH cannot register for this course unit electronically. Forward the lecturer's written permission to attend to the Registrar's Office. Alternatively, the lecturer may also send an email directly to <a href="mailto:kanzlei@rektorat.ethz.ch">kanzlei@rektorat.ethz.ch</a>. The Registrar's Office will then register you for the course.</td>
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<thead>
<tr>
<th>401-3913-01L Mathematical Foundations for Finance</th>
<th>W</th>
<th>4 credits</th>
<th>3V+2U</th>
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<tbody>
<tr>
<td>This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.</td>
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<tr>
<th>401-3901-00L Mathematical Optimization</th>
<th>W</th>
<th>11 credits</th>
<th>4V+2U</th>
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</thead>
<tbody>
<tr>
<td>Mathematical treatment of diverse optimization techniques.</td>
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<tr>
<th>401-6282-00L Statistical Analysis of High-Throughput Genomic and Transcriptomic Data (University of Zurich)</th>
<th>W</th>
<th>5 credits</th>
<th>3G</th>
</tr>
</thead>
<tbody>
<tr>
<td>No enrolment to this course at ETH Zurich. Book the</td>
<td></td>
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</table>
MIND THE ENROLMENT DEADLINES AT UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
A range of topics will be covered, including basic molecular biology, genomics technologies and in particular, a wide range of statistical and computational methods that have been used in the analysis of DNA microarray and high throughput sequencing experiments.

Objective
- Understand the fundamental "scientific process" in the field of Statistical Bioinformatics
- Be equipped with the skills/tools to preprocess genomic data (Unix, Bioconductor, mapping, etc.) and ensure reproducible research (Sweave)
- Have a general knowledge of the types of data and biological applications encountered with microarray and sequencing data
- Have the general knowledge of the range of statistical methods that get used with microarray and sequencing data
- Gain the ability to apply statistical methods/knowledge/software to a collaborative biological project
- Gain the ability to critically assess the statistical bioinformatics literature
- Write a coherent summary of a bioinformatics problem and its solution in statistical terms

Content
Lectures will include: microarray preprocessing; normalization; exploratory data analysis techniques such as clustering, PCA and multidimensional scaling; Controlling error rates of statistical tests (FPR versus FDR versus FWER); limma (linear models for microarray analysis); mapping algorithms (for RNA/ChIP-seq); RNA-seq quantification; statistical analyses for differential count data; isoform switching; epigenomics data including DNA methylation; gene set analyses; classification algorithms to real-world data.

Lecture notes
No lecture notes, published manuscripts

Prerequisites / notice
Prerequisites: Basic knowledge of the programming language R, sufficient knowledge in statistics

Former course title: Statistical Methods for the Analysis of Microarray and Short-Read Sequencing Data

Course code: 401-8625-00L
Course name: Statistical Methods in Clinical Research (University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: STA404

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Discussion of the different statistical methods that are used in clinical research.

Content
Discussion of the different statistical methods that are used in clinical research. Among other subjects the following will be introduced: sample size calculation, randomization and blinding, analysis of clinical trials (parallel groups design, analysis of covariance, crossover design, equivalence studies), intention-to-treat analysis, multiple testing, group sequential methods, adaptive designs, diagnostic studies, and agreement studies.

Literature

Prerequisites / notice
Basic knowledge of the programming language R, sufficient knowledge in calculus, linear algebra, probability, statistics

Course code: 252-0535-00L
Course name: Machine Learning
5 credits

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.
Statistical and Mathematical Courses: not eligible for credits

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
401-6215-00L | Using R for Data Analysis and Graphics (Part I) | E- | 1 credit | 1G | A. J. Papritz, C. B. Schwierz

Objective
The students will be able to use the software R for simple data analysis.

Content
The course provides the first part of an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.

Prerequisites
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contri/Lam-IntroductionToR_LHL.pdf

Lecture notes
The course resources will be provided via the Moodle web learning platform. Please login with your ETH (or other University) username-password at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Please choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

Application Areas
Students select one area of application and look for suitable courses in which quantitative methods and modeling play a role. They need the consent by the Advisor (http://stat.ethz.ch/~kalisch/) that the chosen courses are eligible in the category "Application Areas".

For the category assignment of eligible courses keep the choice "no category" and take contact with the Study Administration Office (www.math.ethz.ch/studienadministration/staff/ekuen) after having received the credits. The Study Administration Office needs the Advisor's consent.

Seminar or Semester Paper

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
401-3630-06L | Semester Paper ■ | W | 6 credits | 9A | Professors

Abstract
Semester papers serve to delve into a problem in statistics and to study it with the appropriate methods or to compile and clearly exhibit a case study of a statistical evaluation.

401-3630-04L | Semester Paper ■ | W | 4 credits | 6A | Professors

Abstract
Semester papers serve to delve into a problem in statistics and to study it with the appropriate methods or to compile and clearly exhibit a case study of a statistical evaluation.

252-5051-00L | Advanced Topics in Machine Learning ■ | W | 2 credits | 2S | J. M. Buhmann, T. Hofmann, A. Krause

Abstract
In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning.

Objective
The seminar "Advanced Topics in Machine Learning" familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.
The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.

The papers will be presented in the first session of the seminar.

**Compulsory Electives in Humanities, Social and Political Sciences**

Recommended GESS compulsory elective courses (Type B) for D-MATH.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

**Master Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Target audience:
- Third year Bachelor students;
- Master students who cannot document to have received an adequate training in working scientifically.

Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later. Optional for Bachelor and Master students with matriculation until or before the spring semester 2014. Example: You matriculated in the autumn semester 2013 into the first semester of the Bachelor programme, are now in the third year and plan to matriculate in the autumn semester 2016 into the first semester of the Master programme. In this case, you don't need "Scientific Works in Mathematics" in order to complete the Bachelor degree, but for the Master degree you will need it. In this case, we recommend that you register for "Scientific Works in Mathematics" in the autumn semester 2015 or spring semester 2016.


Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

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<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>401-4990-02L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>57D</td>
<td>Professors</td>
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Only students who fulfill the following criteria are allowed to begin with their master's thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. They have acquired at least 16 credits in the category Core Courses.

No direct enrolment to this course unit in myStudies. Please fill in the online application form.

Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html

Abstract
The master's thesis concludes the study programme. Thesis work should prove the students’ ability to independent, structured and scientific working.

Objective
Thesis work should prove the students’ ability to independent, structured and scientific working.

Content
Five-month project to solve a research question. The content can be more theoretical (e.g. proving a new result) or applied (developing new methods or making a very sophisticated application and adapting existing methods).

Prerequisites / notice
Supervisors are chosen on a first-come-first-served basis. Collaborations with industry are possible.

**Statistics Master - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Suitable for</th>
<th>Eligible for credits</th>
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</thead>
<tbody>
<tr>
<td>Dr</td>
<td>Doctorate</td>
<td>W</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
</tr>
<tr>
<td>Key for Hours</td>
<td>ECTS</td>
<td>European Credit Transfer and Accumulation System</td>
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<tr>
<td>V</td>
<td>lecture</td>
<td>Special students and auditors need special permission from the lecturers.</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>
### Environmental Engineering Bachelor

#### 1. Semester

#### ▶ First Year Examinations (1. Sem.)

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>401-0241-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7 credits</td>
<td>5V+2U</td>
<td>M. Akveld</td>
</tr>
<tr>
<td></td>
<td>Abstract: Mathematical tools for the engineer</td>
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<tr>
<td></td>
<td>Objective: Basic mathematical knowledge for engineers.</td>
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<tr>
<td></td>
<td>Content: Complex numbers. Calculus for functions of one variable with applications. Simple Mathematical models in engineering.</td>
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<tr>
<td></td>
<td>Lecture notes: Die Vorlesung folgt weitgehend</td>
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<tr>
<td></td>
<td>Neben Akveld, M. &amp; Sperb, R.: Analysis I, vdf, auch</td>
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<tr>
<td>401-0141-00L</td>
<td>Linear Algebra and Numerical Analysis</td>
<td>O</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>P. Grohs</td>
</tr>
<tr>
<td></td>
<td>Abstract: Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.</td>
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<tr>
<td></td>
<td>Objective: To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB.</td>
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<tr>
<td></td>
<td>Content: Linear systems of equations, Vector and matrix calculus, Subspaces and bases, The Euclidean space Rn, Numerical linear algebra with MATLAB, Linear mappings.</td>
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<td></td>
<td>Lecture notes: Lecture Slides will be provided for Download.</td>
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<tr>
<td></td>
<td>Literature: G. Strang, Lineare Algebra, Springer</td>
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<tr>
<td>252-0845-00L</td>
<td>Computer Science I</td>
<td>O</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>M. Hirt</td>
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<tr>
<td></td>
<td>Abstract: The course covers the basic concepts of computer programming.</td>
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<td></td>
<td>Objective: Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.</td>
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<tr>
<td></td>
<td>Content: Variables, Types, Kontrollanweisungen, Prozeduren und Funktionen, Scoping, Rekursion, dynamische Programmierung, vektorisierte Programmierung, Effizienz.</td>
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<tr>
<td></td>
<td>Lecture notes: Als Lernsprachen werden Pascal und Matlab verwendet.</td>
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<tr>
<td>101-0031-01L</td>
<td>Systems Engineering</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>B. T. Adey, C. Richmond</td>
</tr>
<tr>
<td></td>
<td>Abstract: An introduction to system development, analysis and optimization, and decision making, with focus on linear programming, networks, formal decision methods and economic analysis.</td>
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<td></td>
<td>Objective: - to gain competency in methods used to plan and analyse systems - to gain the ability to formulate, analyse and solve complex problems - to gain competency in the methods used for the evaluation of multiple solutions</td>
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<td></td>
<td>Content: Introduction - System development - System analysis - Networks - Decision theory - Economic analysis - Cost-benefit analysis</td>
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<td></td>
<td>Lecture notes: Script and transparencies as well as additional material via Moodle.</td>
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<tr>
<td>651-0032-00L</td>
<td>Geology and Petrography</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>C. A. Heinrich, S. Löw, K. Rauchenstein</td>
</tr>
<tr>
<td></td>
<td>Abstract: This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.</td>
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<td></td>
<td>Objective: This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.</td>
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<td></td>
<td>Lecture notes: Übungen zum Gesteinsbestimmen und Lesen von geologischen, tektonischen und geotechnischen Karten, einfache Konstruktionen.</td>
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<tr>
<td>Literature: The course is based on the book Dynamic Earth from Press &amp; Siever</td>
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<tr>
<td>529-2001-00L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
<tr>
<td></td>
<td>Abstract: The course is based on the book Dynamic Earth from Press &amp; Siever</td>
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<tr>
<td>Literature: Press, F.; Siever, R.: Allgemeine Geologie, Spektrum Akademischer Verlag, Heidelberg</td>
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</tbody>
</table>
Abstract
General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

Objective
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

Content
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

Lecture notes
ca. 360 Seiten mit vielen Figuren und durchgerechneten Beispielen.

Literature

Weiterführende Literatur:
Brown, LeMay, Bursten CHEMIE (deutsch)
Housecroft and Constable, CHEMISTRY (englisch)
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

3. Semester

Compulsory Courses 3. Semester

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0023-01L</td>
<td>Physics</td>
<td>O</td>
<td>7 credits</td>
<td>5V+2U</td>
<td>L. Degiorgi</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interplay between basic research and applications.</td>
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<tr>
<td></td>
<td>Content</td>
<td>Elektromagnetismus: Elektrostatik und Magnetostatik, Strom, Spannung und Widerstand, Maxwell-Gleichungen, elektromagnetische Wellen, elektromagnetische Induktion, elektromagnetische Eigenschaften der Materie, Thermodynamik: Temperatur und Wärme, Zustandsgleichungen, erster und zweiter Hauptsatz der Wärmelehre, Entropie, Transportvorgänge, Quantenphysik und Atompysik, Schwingungen und Wellen, Grundlagen der speziellen Relativitätstheorie.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
<td>Manuskript und Übungsblätter</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Literature</td>
<td>Hans J. Paus, Physik in Experimenten und Beispielen, Carl Hanser Verlag München Wien (als unterrichtsbegleitendes und ergänzendes Lehrbuch)</td>
<td></td>
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<tr>
<td>101-0203-01L</td>
<td>Hydraulics I</td>
<td>O</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>R. Stocker</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.</td>
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<tr>
<td></td>
<td>Objective</td>
<td>Familiarization with the basics of hydromechanics of steady state flows</td>
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<tr>
<td></td>
<td>Content</td>
<td>Properties of water, hydrostatics, continuity, Euler equation of motion, Navier Stokes equation, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids-real fluids, boundary layer, pipe flow, open channel flow, flow in porous media, flow measurements, demonstration experiments in the lecture hall and in the laboratory</td>
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<tr>
<td></td>
<td>Lecture notes</td>
<td>Script and collection of problems available</td>
<td></td>
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<tr>
<td></td>
<td>Literature</td>
<td>Bolirich, Technische Hydromechanik 1, Verlag Bauwesen, Berlin</td>
<td></td>
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<tr>
<td>103-0233-01L</td>
<td>GIS I</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Donaubauer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>Fundamentals of geoinformation technologies: spatial data modeling, metrics &amp; topology, vector and raster data, thematic data, spatial queries and analysis, spatial databases; labs with GIS software</td>
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<td></td>
<td>Objective</td>
<td>Knowing the fundamentals of geoinformation technologies for the realization, application and operation of geographic information systems in engineering projects.</td>
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<tr>
<td></td>
<td>Content</td>
<td>Einführung GIS &amp; GIScience, Konzeptionelles Modell &amp; Datenschema, Vektorgeometrie &amp; Topologie, Rastergeometrie und -algebra, Thematische Daten, Räumliche Abfragen &amp; Analysen, Geodatenbanken</td>
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<tr>
<td></td>
<td>Lecture notes</td>
<td>Vorlesungspräsentationen werden digital zur Verfügung gestellt.</td>
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<tr>
<td>102-0293-00L</td>
<td>Hydrology</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>The course introduces the students to engineering hydrology. It covers first physical hydrology, that is the description and the measurement of hydrological processes (precipitation, interception, evapotranspiration, runoff, erosion, snow), and it introduces then the basic mathematical models of the single processes and of the rainfall-runoff transformation, thereby including flood analysis.</td>
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<td>Objective</td>
<td>Know the main features of engineering hydrology. Apply methods to estimate hydraulic variables for dimensioning hydraulic structures and managing water resources.</td>
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</tbody>
</table>
Content
Der hydrologische Kreislauf: globale Wasserressourcen, Wasserbilanz, räumliche und zeitliche Dimension der hydrologischen Prozesse.


Interzeption: Messung und Schätzung.

Evaporation und Evapotranspiration: Prozesse, Messung, Schätzung, potentielle und effektive Evapotranspiration, Energiebilanzmethode, empirische Methode.

Infiltration: Messung, Horton-Gleichung, empirische und konzeptionelle Methoden, F-index und Prozentuale Methode, SCS-CN Methode.

Einzugsgebietscharakteristik: Morphologie des Einzugsgebiets, topografische und unterirdische Wasserscheide, hysmorphische Kurve, Gefälle, Dichte des Entwässerungsetzes.


Schnee und Eis: Schneeeigenschaften und -messungen Schätzung des Schneeschmelzprozesses durch die Energiebilanzmethode, Abfluss aus Schneespeicher, Temperatur-Index- und Grad-Tag-Verfahren.


Lecture notes
Ein internes Skript ist zur Verfügung (kostenpflichtig, nur Herstellungskosten)

Die Kopie der Folien zur Vorlesung können auf den Webseiten der Professur für Hydrologie und Wasserwirtschaft herunterladen werden

Literature


Prerequisites / notice
Vorlesende zu Hydrologie I sind die Vorlesungen in Statistik. Der Inhalt, der um ein Teil der Übungen zu behandeln und um ein Teil der Vorlesungen zu verstehen notwendig ist, kann zusammengefasst werden, wie hintereinander es beschrieben wird:

Elementare Datenverarbeitung: Hydrologische Messungen und Daten, Datenreduzierung (grafische Darstellungen und numerische Kenngrössen).


701-0243-01L

Biology III: Essentials of Ecology
0 3 credits 2V S. Güsewell, C. Vorburger

Abstract
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems; corresponding methodological approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

Objective
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

The students should learn ecological concepts at these different levels in the context of concrete examples from terrestrial and aquatic ecology. Corresponding methods for studying the systems will be presented.

A further aim of the lecture is that students achieve an understanding of biodiversity, why it is threatened and how it can be managed.

Content
- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflusse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Lecture notes
Unterlagen, Vorlesungsfolien und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Literature
Generelle Ökologie:


Aquatische Ökologie:

Lampert & Sommer 1999. Limnoökologie. Thieme, 2. Aufl., ca. Fr. 55.-;

Bohle 1995. Limnische Systeme. Springer, ca. Fr. 50.-

Naturschutzbiologie:


►►► Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-4001-00L</td>
<td>Microbiology</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Ackermann, M. Schupper, J. Vorholt-Zambelli</td>
</tr>
</tbody>
</table>

Abstract
Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

Objective
Teaching of basic knowledge in microbiology.
Content

Lecture notes
Wird von den jeweiligen Dozenten ausgegeben.

Literature
Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

701-0255-00L Biochemistry O 2 credits 2V H.P. Kohler
Abstract
Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.

Objective
Students are able to understand
- the structure and function of biological macromolecules
- the kinetic bases of enzyme reactions
- thermodynamic and mechanistic basics of relevant metabolic processes
Students are able to describe the relevant metabolic reactions in detail

Content
Program
Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates
Lipids and biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

Lecture notes
Horton et al. (Pearson) serves as lecture notes.

Prerequisites / notice
Basic knowledge in biology and chemistry is a precondition.

5. Semester

Compulsory Courses 5. Semester

Examination Block 3

As of examination session winter 2015, examination block 3 will be implemented in its new structure (i.e. new, Earth Observation will be examined within examination block 3 instead of within examination block 4). The new structure is valid for those students NOT having taken exams of examination block 3 nor of examination block 4 for the first time. All other students take the exams of examination block 3 as well as of examination block 4 in the present structure, including repetition where applicable.

Number Title Type ECTS Hours Lecturers
102-0215-00L Urban Water Management II O 3 credits 2G M. Maurer, P. Staufer
Abstract

Objective
Consolidation of the basic procedures for design and operation of technical networks in water engineering.

Content
Demand Side Management versus Supply Side Management
Druckstösse
Kalkausfällung, Korrosion von Leitungen
Hygiene in Verteilsystemen
Siedlungshydrologie: Niederschlag, Abflussbildung
Instationäre Strömungen in Kanalisationen
Stofftransport in der Kanalisation
Einleitbedingungen bei Regenwetter
Versickerung von Regenwasser
Generelle Entwässerungsplanung (GEP)

Lecture notes
Written material and copies of the overheads will be available.

Prerequisites / notice
Prerequisite: Introduction to Urban Water Management

102-0455-01L Groundwater I O 3 credits 2G M. Willmann
Abstract
The course provides an introduction into quantitavie analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective
a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.
Content

Introduction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.

Flow equations, stream function.
Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.

Transport processes.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes
Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index
Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature
W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970
G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

102-0635-01L Air Pollution Control O 6 credits 4G B. Buchmann, P. Hofer

Abstract
The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their impact on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society.

Objective
The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. The students know the different techniques of air pollution control and their scientific basements. They are able to incorporate goals concerning the air quality into their engineering work.

Content
Part 1 Emission, Immission, Transmission
Fluxes of pollutants and their environmental impact
- physical and chemical processes leading to emission of pollutants
- mass and energy of processes
- Emission measurement techniques and concepts
- quantification of emissions from individual and aggregated sources
- extent and development of the emissions (Switzerland and global)
- propagation and transport of pollutants (transmission)
- meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- dispersion models (Gaussian model, box model, receptor model)
- measurement concepts for ambient air (immission level)
- extent and development of ambient air mixing ratios
- goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (process-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
  - Procedures for the removal of particles (inertial separator, filtration, electrostatic pre-cipitators, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms.
  - Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
  - Discussion of the technical possibilities to solve the actual air pollution problems.
The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation.

Objective

The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation. Students should know at the end of the course:

1. Basics of measurement principle
2. Fundamentals of image acquisition
3. Basics of the sensor-specific geometries
4. Sensor-specific determination of environmental parameters

Content

Die Lehrveranstaltung gibt einen Einblick in die heutige Erdbeobachtung mit dem folgenden skizzierten Inhalt:

1. Einführung in die Fernerkundung von Luft- und Weltraum gestützen Systemen
2. Einführung in das Elektromagnetische Spektrum
3. Einführung in optische Systeme (optisch und hyperspektral)
4. Einführung in Mikrowellen-Technik (aktiv und passiv)
5. Einführung in atmosphärische Systeme (meteo und chemisch)
6. Einführung in die Techniken und Methoden zur Bestimmung von Umweltparametern
7. Einführung in die Anwendungen zur Bestimmung von Umweltparametern in der Hydrologie, Glaziologie, Forst und Landwirtschaft, Geologie und Topographie

Lecture notes

Folien zu jeden Vorlesungsblock werden zur Verfügung gestellt.

Literature

Ausgewählte Literatur wird am Anfang der Vorlesung vorgestellt.
The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for biogeophysical environmental parameter estimation.

**Objective**

The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for biogeophysical environmental parameter estimation. Students should know at the end of the course:

1. Basics of measurement principle
2. Fundamentals of image acquisition
3. Basics of the sensor-specific geometries
4. Sensor-specific determination of environmental parameters

**Content**

Die Lehrveranstaltung gibt einen Einblick in die heutige Erdbearchtung mit dem folgenden skizzierten Inhalt:

1. Einführung in die Fernerkundung von Luft- und Weltraum gestützten Systemen
2. Einführung in das Elektromagnetische Spektrum
3. Einführung in optische Systeme (optisch und hyperspektoral)
4. Einführung in Mikrowellen-Technik (aktiv und passiv)
5. Einführung in atmosphärische Systeme (meteo und chemisch)
6. Einführung in die Techniken und Methoden zur Bestimmung von Umweltparametern
7. Einführung in die Anwendungen zur Bestimmung von Umweltparametern in der Hydrologie, Glaziologie, Forst und Landwirtschaft, Geologie und Topographie

**Lecture notes**

Folien zu jedem Vorlesungsblock werden zur Verfügung gestellt.

**Literature**

Ausgewählte Literatur wird am Anfang der Vorlesung vorgestellt.

---

**851-0703-03L Introduction to Law for Civil Engineering**

Only for Civil Engineering BSc, Geomatic Engineering and Planning BSc, Environmental Engineering BSc and Spatial Development and Infrastructure Systems MSc

Students who have attended or will attend the lecture "Introduction to Law for Architecture" (851-0703-01L) cannot register for this course unit.

**Abstract**

This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

**Objective**

Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

1. Public Law
   - Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

2. Private law

**Lecture notes**

There will be 'Lecture Notes' (in German) for this course, starting in Fall 2015

**Literature**

Further information is available at http://www.hertig.ethz.ch/courses.html

---

**851-0709-00L Introduction to Civil Law**

Only for Civil Engineering BSc, Geomatic Engineering and Planning BSc, Environmental Engineering BSc and Spatial Development and Infrastructure Systems MSc

**Abstract**

The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.

**Objective**


**Content**

Le cours d'introduction au droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

**Literature**

Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des librairies.

Sont indispensables:
- le Code civil et le Code des obligations;
- Nef, Urs Ch., Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève

**Prerequisites / notice**

Remarques
- le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

**101-0515-00L Project Management**

Only for Civil Engineering BSc and MSc, Geomatic Engineering and Planning BSc, Environmental Engineering BSc

**Abstract**

General introduction to the development, the life cycle and the characteristics of projects. Introduction to, and experience with, the methods and tools to help with the preparation, evaluation, organisation, planning, controlling and completion of projects.

**Objective**

To introduce the methods and tools of project management. To impart knowledge in the areas of project organisation and structure, project planning, resource management, project controlling and on team leadership and team work.

**Content**

- From strategic planning to implementation (Project phases, goals, constraints, and feasibility)
- Project leadership (Leadership, Teams)
- Project organization (Structure)
- Project planning (Schedule, cost and resource planning)
- Project controlling
- Risk and Quality Management
- Project completion

**Lecture notes**

Yes
The transparencies will be available for download from the website at least one week before each class. Copies of all necessary documents will be distributed at appropriate times.

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**Additional Compulsory Courses**
The students will understand the basics of noise abatement: acoustics, impact of noise, measurement techniques and legislation. The students will be able to analyze different noise prob- lems and they will be able to solve simple problems of noise abatement.

**Objective**

Learn about recent research results in environmental engineering and analyse practical applications in environmental engineering.

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**ECTS**

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**

The course is organized in the form of seminars held by the students. Topics selected from the core disciplines of the curriculum (water resources, urban water engineering, material fluxes, waste technology, air pollution, earth observation) are discussed in the class on the basis of scientific papers that are illustrated and critically reviewed by the students.

**Environmental Geotechnics**

Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems.

**Objective**

Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems.

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**ECTS**

<table>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>102-0503-00L</td>
<td>Noise Abatement</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>K. Eggenschwiler, J. M. Wunderli</td>
</tr>
</tbody>
</table>

**Abstract**


**Objective**

The students will understand the basics of noise abatement: acoustics, impact of noise, measurement techniques and legislation. The students will be able to analyze different noise prob-lems and they will be able to solve simple problems of noise abatement.

---

**ECTS**

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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-0501-00L</td>
<td>Pedosphere</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Kretzschmar</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Objective**

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Content**

Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

**Literature**


**Prerequisites / notice**

Prerequisites: Basic knowledge in chemistry, biology and geology.

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**ECTS**

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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-0533-00L</td>
<td>Soil Chemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Kretzschmar, D. I. Christl</td>
</tr>
</tbody>
</table>

**Abstract**

This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

**Objective**

Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.

**Content**

Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

**Literature**


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**ECTS**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0339-00L</td>
<td>Environmental Geotechnics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. M. Plötzé</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems.

**Objective**

Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems.

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<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Kretzschmar</td>
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**Abstract**

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Objective**

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Content**

Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

**Literature**


**Prerequisites / notice**

Prerequisites: Basic knowledge in chemistry, biology and geology.
Renewable Energy Technologies I
W. H. Hager
Lecture notes will be distributed during the course.

Lecturers
Wastewater Hydraulics

Type: Text books

Definition of contaminated sites, site investigation methods, historical research and technical investigation, risk assessment, contamination transport, remediation, clean-up and retaining techniques (e.g. bioremediation, incineration, retaining walls, pump-and-treat, permeable reactive barriers), monitoring, research projects and results

Dr. R. Hermanns Stengele, Dr. M. Plötze: Environmental Geotechnics (german) digital

Wastewater Hydraulics

The understanding and the computation of the essential hydraulic processes in wastewater hydraulics are presented. On the one hand, free-surface hydraulics is reviewed with particular reference to problems in wastewater hydraulics, whereas various special hydraulic structures such as manholes, separation structures and collector channels are analyzed with a hydraulic approach on the other hand. Particularities of wastewater schemes including depositions and the choking of a sewer as the abrupt transition from free-surface to pressurized high-speed flow are highlighted.

Prerequisites / notice
Excursion

101-1249-00L Wastewater Hydraulics W 3 credits 2G W. H. Hager

Abstract
The basics of wastewater hydraulics are described from the environmental and the hydraulic points of views thereby presenting also examples from engineering practice. Typical case studies are further described during a laboratory visit of VAW.

Objective
The understanding and the computation of the essential hydraulic processes in wastewater hydraulics are presented. On the one hand, free-surface hydraulics is reviewed with particular reference to problems in wastewater hydraulics, whereas various special hydraulic structures such as manholes, separation structures and collector channels are analyzed with a hydraulic approach on the other hand. Particularities of wastewater schemes including depositions and the choking of a sewer as the abrupt transition from free-surface to pressurized high-speed flow are highlighted.

Content
Fundamentals
Hydraulic losses
Design of hydraulic elements
Uniform flow
Critical flow
Energy dissipation
Backwater curves
Culvert and inverted siphon
Overflows
Venturi flume
Mobile discharge measurement
Drop and vortex drop
Bend and junction manhole
Sidewall
Lateral overflow
Bottom opening
Side channel

Lecture notes
Text books


Exhaustive references are contained in the 'scripts'.

Literature

Visit of VAW hydraulic laboratories to add to applied resources. Description of a number of selected, at the time available hydraulic models.

Elective Block: Energy

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
529-0193-00L | Renewable Energy Technologies I | W | 4 credits | 3G | A. Wokaun, A. Steinfield

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaics electricity, solar chemistry), Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed during the course.

Literature
- Heinloth, K.; Die Energiefrage (Vieweg, 2003)

Prerequisites / notice
Fundamentals of chemistry and physics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Electives ETH Zurich

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-BAUG.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
### Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0006-00L</td>
<td>Bachelor's Thesis</td>
<td>O</td>
<td>10</td>
<td>20D</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**
The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

**Objective**
Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

**Content**
The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

### Environmental Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

### Key for Hours

<table>
<thead>
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<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Environmental Engineering Master

1. Semester

Compulsory Specialized Computer Laboratory for Env. Engin.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
Technical systems are investigated in projects with measurement campaigns and numerical modeling. The students learn how to answer given questions with target oriented methodologies.

Objective
Technical systems are investigated in projects with measurement campaigns and numerical modeling. The students learn how to answer given questions with target oriented methodologies.

Content
The following projects are conducted:
- Construction, operation and characterization of a mini wastewater treatment plant
- Characterization of aquifers with pumping experiments
- Modeling of hydrological systems
- Measuring and modeling of nanoparticles at workplaces
- Measuring and modeling of sediment transport in rivers
- Investigations of polluted terrain

Lecture notes
Written material will be available.

Major Courses

Major in Water Resources Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fatiichi</td>
</tr>
</tbody>
</table>

Abstract
The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective
Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.

Content

Lecture notes
Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature
Additional literature is presented during the course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Holzner</td>
</tr>
</tbody>
</table>

Abstract
In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.

Objective
The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

Content
The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes
Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Literature
Given in lecture

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>102-0287-00L</td>
<td>Fluvial Systems</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Molnar</td>
</tr>
</tbody>
</table>

Abstract
The course presents an integrated view of the river basin and fluvial system. The fluvial system is viewed in terms of the dynamics in the transfer of water and sediment, the resulting geomorphology of the river network and streams, and finally the basin and river management options for conservation and restoration.

Objective
The goal of the course is to develop process-understanding of fluvial systems and to introduce the students to appropriate analysis tools.

Content
In the first section the estimation of basin sediment supply from upland sheet, rill and gully erosion, and basin sediment yield are discussed. The second section focuses on sediment transport in rivers in general, e.g. basic mechanics of sediment laden flows, bedforms, flow resistance, sediment type and load measurement and estimation, the morphology of rivers. It is illustrated how the river network can be represented in terms of its connectivity and topological characteristics. Channel stability and channel erosion modelling are discussed. The third section looks at fluvial system management in terms of engineering and nonstructural sediment (e.g. upland and channel erosion protection) and water (e.g. the importance of the natural streamflow regime on riverine ecosystem integrity, river rehabilitation) resource management.

Lecture notes
There is no script.

Literature
Study materials (lecture handouts and selected papers) are distributed in class and available on the web.

Prerequisites / notice
Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

Major in Urban Water Management

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>102-0217-00L</td>
<td>Process Engineering I (Biological Processes)</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
</tbody>
</table>

Abstract
Introduction of kinetic models for activated sludge systems and biological nutrient removal as a basis for design and dynamic simulation: Nitrification, denitrification, biological phosphorus removal (ASM1 to ASM3). Kinetics of biofilms, application to full scale reactors. Anaerobic treatment schemes, industrial waste, biogas production, sludge handling. Aerobic thermophilic processes.
The goal of this unit is to provide the background for the understanding, design and simulation of today's biological wastewater treatment and sludge stabilization processes. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.

**Content**
- Microbial transformation processes
- Introduction to the activated sludge process
- Modeling activated sludge systems
- Nitrification / denitrification / biological P elimination
- Enrichment, selectors, filamentous growth
- Biofilm kinetics and application to full scale plants
- Anaerobic processes, industrial applications, sludge stabilization
- Aerobic thermophilic processes

**Lecture notes**
Copies of overheads will be made available.

**Literature**
There will be a required textbook that students need to purchase (see http://wwwifu.ethz.ch/SWW/education/lectures/Proc_Eng_I for further information).

**Prerequisites / notice**
This course will be offered together with the course Systems Analysis and Mathematical Modeling. It is advantageous to follow both courses simultaneously. For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://wwwifu.ethz.ch/SWW/education/lectures/Proc_Eng_I.

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**102-0227-00L** Systems Analysis and Mathematical Modeling in Urban Water Management

**Objective**
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

**Content**
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, kinetics, stoichiometry and conservation
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

**Lecture notes**
Copies of overheads will be made available.

**Literature**
There will be a required textbook that students need to purchase:

**Prerequisites / notice**
This course will be offered together with the course Process Engineering I. It is advantageous to follow both courses simultaneously.

---

**Major in Ecolog. Systems Design, Air Quality Contr. and Waste Manag.**

*In the Major in "Ecolog. Systems Design, Air Quality Contr. and Waste Manag." one out of three possible combinations of modules must be taken:*

1st combination: ESD & Air Quality Control;
2nd combination: Air quality control & Waste management;
3rd combination: Waste management & ESD.

Students that choose either combination 2 or 3 and have Urban Water Management as a second Major need to take course "102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories" (offered in spring semester) instead of "102-0217-00L Process Engineering I (Biological Processes)."

---

**Number** 102-0217-00L  
**Title** Process Engineering I (Biological Processes)  
**Type** O  
**ECTS** 3 credits  
**Hours** 2G  
**Lecturers** E. Morgenroth

**Abstract**
Introduction of kinetic models for activated sludge systems and biological nutrient removal as a basis for design and dynamic simulation: Nitrification, denitrification, biological phosphorus removal (ASM1 to ASM3). Kinetics of biofilms, application to full scale reactors. Anaerobic treatment schemes, industrial waste, biogas production, sludge handling. Aerobic thermophilic processes.

**Objective**
The goal of this unit is to provide the background for the understanding, design and simulation of today's biological wastewater treatment and sludge stabilization processes. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.

**Content**
- Microbial transformation processes
- Introduction to the activated sludge process
- Modeling activated sludge systems
- Nitrification / denitrification / biological P elimination
- Enrichment, selectors, filamentous growth
- Biofilm kinetics and application to full scale plants
- Anaerobic processes, industrial applications, sludge stabilization
- Aerobic thermophilic processes

**Lecture notes**
Copies of overheads will be made available.

**Literature**
There will be a required textbook that students need to purchase (see http://wwwifu.ethz.ch/SWW/education/lectures/Proc_Eng_I for further information).

**Prerequisites / notice**
This course will be offered together with the course Systems Analysis and Mathematical Modeling. It is advantageous to follow both courses simultaneously. For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://wwwifu.ethz.ch/SWW/education/lectures/Proc_Eng_I.

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**Number** 102-0307-00L  
**Title** Advanced Environmental, Social and Economic Assessments  
**Type** O  
**ECTS** 6 credits  
**Hours** 3G+2U+2P  
**Lecturers** A. E. Braunschweig, S. Pfister, R. Frischknecht
Abstract
This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.

Objective
This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.

In particular, students completing the course should have the
- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of...", students will learn to
- describe key sustainability problems of the current economic system and measuring units;
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance)
- explain the pros and cons of single score env. assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management

Content
Part I: (Advanced Environmental Assessments)
- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multioutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Case Studies

Part II (Implementation of Environmental and other Sustainability Goals):
- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
- The concept of 'Continuous Improvement'
- Life Cycle Costing, Life Cycle Management
- environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance), based on practical examples of companies and new concepts
- single score env. assessment methods (Swiss ecopoints)
- stakeholder management and sustainability oriented communication
- an intro into sustainability issues of supply chain management

Students will get small exercises related to course issues.

Part III (Computer Lab): this is an exercise and software lab to apply the methods from Part I and II of this lecture.

Lecture notes
Part I: (-)
Part II: Documents will be available on Ilias
Part III Lab: (-)

Literature
Will be made available in class.

Prerequisites / notice
This course should only be elected by students of environmental engineering with the Major in ESD, Air Quality Control and Waste Management. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Baumann&Tillman, The Hitchhiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications, Studentlitteratur, Lund, 2004).

102-0357-00L Waste Recycling Technologies O 3 credits 2G R. Bunge

Abstract
Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central Europe, it is only just now catching on in emerging markets as well.

Objective
At the core of this course is the separation of solid materials according to their physical properties such as color, electrical conductivity, magnetism and so forth. After having taken this course, the students should have concept not only of the unit operations employed in WRT but also of how these unit operations are integrated into the flow sheets of production plants.

Content
Introduction
Waste Recycling; Scope and objectives
Waste recycling technologies in Switzerland

Fundamentals
Properties of particles; Liberation conditions, Particle size and shape, Porosity of bulk materials
Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles
Flow sheet basics: Balancing mass flows
Standard processes: batch vs. continuous
Assessment of separation success: Separation function; grade vs. recovery

Separation Process
Separation according to size and shape (Classification); Screening, Flow separation
Separation according to material properties (Concentration): Magnetic sorting, Gravity concentration; Magnetic separation, Eddy current separation, Electrostatic separation, Sensor technology, Froth flotation

Lecture notes
The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server.

Literature
A list of recommended books will be provided.

Prerequisites / notice
We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.

102-0377-00L Air Pollution Modeling and Chemistry O 3 credits 2G S. Henne, A. C. Gerecke

Abstract
Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water, ...).

Objective
The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.

Content
- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

Lecture notes
Hand-outs of lecture material with extended comments will be made available along with the lecture.

Literature
Lists of suitable books and papers will be provided in the lecture.

Prerequisites / notice
strongly recommended: 102-0635-01L Luftreinhaltung (Air Pollution Control) or similar

102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories •

Abstract
Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

Objective
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

Content
This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radon/uranium transport in geological media.

Lecture notes
Short script plus copies of overheads

Literature
This is a mandatory course aimed at environmental scientists and environmental engineers.


>>> Major in Hydraulic Engineering

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>101-0247-01L</td>
<td>Hydraulic Engineering II</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>R. Boes</td>
</tr>
</tbody>
</table>

Abstract
Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.

Objective
Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety.

Content
Weirs: Weir stability, gates, inflatable dams, appurtenant structures.
Conduits: Design of headrace, pressure shafts, and penstocks, constructive details and construction.
Dams: Dam types, appurtenant structures (diversion, spillways, bottom outlet), dam type selection criteria, layout and design of gravity dams, buttress dams, arch dams, rockfill dams with central core or concrete face, measures in the foundation, mass concrete, RCC dams, reservoir siltation and sediment management, dam surveillance.
Artificial reservoirs: Purpose, layout, sealing, appurtenant structures, environmental aspects.

Lecture notes
manuscript and further documentation

Literature
is specified in the lecture and in the manuscript

Prerequisites / notice
Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications •

Abstract
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

Objective
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of
1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

ECTS 3 credits 2G I. Hajnsek
Content

The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

Lecture notes

Handouts for each topic will be provided

Literature

First readings for the course:

Complete literature listing will be provided during the course.

Prerequisites / notice

This course in combination with 102-0627-00-G: Applied Radar Remote Sensing for Environmental Parameter Estimation is providing a profound basis for independent data analysis. It is recommended to take both courses together.

101-0258-00L River Engineering O 3 credits 2G G. R. Bezzola

Abstract

Main subjects treated:
- Fundamentals (e.g. sediment sampling methods), alluvial channel hydraulics, incipient motion, bed forms, bed load and suspended load, sediment budget and morphological changes, river morphology, scour, river management concepts and selected measures (e.g. bank and bed protection works).
- A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.

Objective

The students shall
- be able to describe quantitatively the interrelation between discharge, sediment transport and channel evolution
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration

Content

The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, of bed load and suspended load transport are treated.

In the second part of the lecture the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation, and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of bed forms, river morphology and scour.

The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics treated are the stabilization of banks and of the longitudinal profile of rivers.

101-0269-00L Numerical Modelling in Fluvial Hydraulics and River Engineering W 3 credits 2G D. F. Vetsch, A. Siviglia

Abstract

The basics of numerical modelling of fluvial hydraulics and river engineering problems are presented. The governing equations for flow and sediment transport in open channels and corresponding numerical solution strategies are introduced. The theoretical parts are discussed by examples.

Objective

Get to know possibilities and limitations of numerical modelling in fluvial hydraulics and river engineering.

Content

- Governing equations and modelling approaches
- Initial and boundary conditions
- Simulation process and grid generation
- Numerical methods; basics, accuracy and stability
- Examples of numerical schemes, 1D and 2D models

Lecture notes

Slides of lecture are available for download as PDF. Supplementary material will be provided during lecture.

Literature

Relevant books and citations will be mentioned.

Prerequisites / notice

Exercises are based on the simulation software BASEMENT (www.basement.ethz.ch), the open-source GIS Qgis (www.qgis.org) and code examples written in MATLAB. The applications comprise one- and two-dimensional approaches for the modelling of flow and sediment transport.


Major in Soil Protection

As replacement of 101-0314-99 Soil Mechanics, one of following three courses is compulsory for students of major Soil Protection:
1. 651-4033-00 Soil Mechanics and Foundation (HS), or
2. 751-3404-00L Nutrient Fluxes in Soil-Plant Systems (FS), or
3. 701-1802-00L Ökologie von Waldböden (FS).

Number Title Type ECTS Hours Lecturers

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology O 3 credits 2G+2U D. Or

Abstract

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective

Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
Weeks 1 to 3: Physical Properties of Soils and Other Porous Media  Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.
Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
Midterm exam
Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.
Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporaporation.

Week 12 to 13: Solute Transport in Soils Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.
Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester) http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

Lecture notes
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester) http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Lecture notes
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Lecture notes
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Prerequisites / notice
Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

701-1315-00L Biogeochemistry of Trace Elements O 3 credits 2G A. Voegelin, J. G. Wiederhold, L. Winkel

701-1681-00L Element Balancing and Soil Functions in Managed Ecosystems O 3 credits 2G A. Keller

701-1315-00L Biogeochemistry of Trace Elements O 3 credits 2G A. Voegelin, J. G. Wiederhold, L. Winkel

701-1681-00L Element Balancing and Soil Functions in Managed Ecosystems O 3 credits 2G A. Keller

The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours. recommended prerequisites for attending this course:
- Bodenschutz und Landnutzung
- Biochemistry of Trace Elements
- Angewandte Bodenökologie

**651-4033-00L**

**Soil Mechanics and Foundation Engineering**

**W 4 credits 3V+2U**

M. Perras, A. Woller, M. Stolz

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**Abstract**

The course presents the principles of soil mechanics and soil behaviour characteristics and its applications in geotechnical structures and systems. It is based on more descriptive courses on Engineering Geology within the BSc Geol. Program and is a compulsory prerequisite for other courses within the MSc Eng. Geol. program.

**Objective**

Understanding the principles of soil behaviour and the fundamentals of geotechnical practices in soils.

Ability to communicate with geotechnical engineers.

**Content**

Soil Mechanics:
- Fundamental concepts of strength and deformation of different soils. Introduction to geotechnical calculations
- Significance of groundwater
- Geotechnical Engineering in Soils:
- Evaluation of geotechnical scenarios, handling of forecast uncertainties, relation of soil properties and soil composition, interactions between soil and building, standard construction methods in soils (foundations, slopes, dams and levees), requirements for the geotechnical prognosis

**Lecture notes**

This lecture is supported by the textbook: "Geotechnical Engineering" by Donald P. Coduto, 2nd edition, 2011; ISBN-13: 978-0-13-135425-8

**Prerequisites / notice**

Courses must be completed:
- Introduction to Engineering Geology (BSc level)
- Introduction to Groundwater
- Sedimentology and Quaternary deposits
- Principles of Physics

Courses recommended:
- Eng Geol Site Investigations
- Eng Geol Field Course I (soils)
- Clay Mineralogy

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### Minors

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<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>102-0227-00L</td>
<td>Systems Analysis and Mathematical Modeling in Urban Water Management</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
</tr>
</tbody>
</table>

**Abstract**


**Objective**

The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

**Content**

- The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
  - Introduction into modeling and simulation
  - The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
  - Ideal reactors
  - Hydraulic residence time distribution and modeling of real reactors
  - Dynamic behavior of reactor systems
  - Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
  - Introduction to process control (PID controller, fuzzy control)

**Lecture notes**

Copies of overheads will be made available.

**Literature**

There will be a required textbook that students need to purchase:

**Prerequisites / notice**

This course will be offered together with the course Process Engineering I. It is advantageous to follow both courses simultaneously.

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<tr>
<td>102-0217-00L</td>
<td>Process Engineering I (Biological Processes)</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
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</table>

**Abstract**

This course will be combined with Systems Analysis and Mathematical Modeling (102-0227-00L). It is therefore advantageous to follow both courses simultaneously.

**Objective**

The goal of this unit is to provide the background for the understanding, design and simulation of todays biological wastewater treatment and sludge stabilization processes. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.

**Content**

Microbial transformation processes.
- Introduction to the activated sludge process
- Modeling activated sludge systems
- Nitrification / denitrification / biological P elimination
- Enrichment, selectors, filamentous growth
- Biofilm kinetics and application to full scale plants
- Anaerobic processes, industrial applications, sludge stabilization
- Aerobic thermophilic processes

**Lecture notes**

Copies of overheads will be made available.

**Literature**

There will be a required textbook that students need to purchase (see http://www.ifu.ethz.ch/SWW/education/lectures/Proc_Eng_I for further information).
Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or man-made structures.

Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety are provided.

Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.

The basics of numerical modelling of fluvial hydraulics and river engineering problems are presented. The governing equations for flow and sediment transport in open channels and corresponding numerical solution strategies are introduced. The theoretical parts are discussed by examples.

The basics of numerical modelling of fluvial hydraulics and river engineering problems are presented. The governing equations for flow and sediment transport in open channels and corresponding numerical solution strategies are introduced. The theoretical parts are discussed by examples.

The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.

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We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

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In order to understand the fundamental physical processes in glaciology, to learn some basic numerical modelling techniques for glacier flow, to identify glaciological hazards and to learn some assessment and mitigation possibilities.

Basics in physical glaciology: Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges, ice falls, ice avalanches, Glacier floods, Lake ice and ice and snow cover.

Weirs: Weir stability, gates, inflatable dams, appurtenant structures.

- Governing equations and modelling approaches
- Initial and boundary conditions
- Simulation process and grid generation
- Numerical methods: basics, accuracy and stability
- Examples of numerical schemes, 1D and 2D models

Related books and citations will be mentioned.

Lecture notes/Handouts will be available online.

Lecture notes/Handouts will be available online.

Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

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Weirs: Weir stability, gates, inflatable dams, appurtenant structures.

Conduits: Design of headraces, pressure shafts, and penstocks, constructive details and construction.

Power plants: Power house and turbine types, design, structure, construction.

Dams: Dam types, appurtenant structures (diversion, spillways, bottom outlet), dam type selection criteria, layout and design of gravity dams, buttress dams, arch dams, rockfill dams with central core or concrete face, measures in the foundation, mass concrete, RCC dams, reservoir siltation and sediment management, dam surveillance.

Artificial reservoirs: Purpose, layout, sealing, appurtenant structures, environmental aspects.

Relevant books and citations will be mentioned.

Lecture notes/Handouts will be available online.

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Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

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The applied glaciology course will present current topics and projects in Switzerland and abroad.

We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

Basics in physical glaciology: Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges, ice falls, ice avalanches, Glacier floods, Lake ice and ice and snow cover.

Handouts are available.

Relevant Literatur wird während der Vorlesung angegeben.

Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Voraussetzungen: Es werden Grundkenntnisse in Mechanik und Physik vorausgesetzt.

The course presents an integrated view of the river basin and fluvial system. The fluvial system is viewed in terms of the dynamics in the transfer of water and sediment, the resulting geomorphology of the river network and streams, and finally the basin and river management options for conservation and restoration.
Objective

The goal of the course is to develop process-understanding of fluvial systems and to introduce the students to appropriate analysis tools. The second section focuses on sediment transport in rivers in general, e.g. basic mechanics of sediment laden flows, bedforms, flow resistance, sediment type and load measurement and estimation, the morphology of rivers. It is illustrated how the river network can be
analysed in terms of its connectivity and topological characteristics. Channel stability and channel erosion modelling are discussed. The
third section looks at fluvial system management in terms of engineering and nonstructural sediment (e.g. upland and channel erosion
protection) and water (e.g. the importance of the natural streamflow regime on riverine ecosystem integrity, river rehabilitation) resource
management.

Lecture notes

There is no script.

Literature

Study materials (lecture handouts and selected papers) are distributed in class and available on the web.

Prerequisites / notice

Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

101-0267-01L Numerical Hydraulics W 3 credits 2G M. Holzner

Abstract

In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.

Objective

The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use
commercial software in a responsible and critical way.

Content

The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their
applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and
finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the
shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the
students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes

Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Literature

Given in lecture

102-0272-00L Hydrology II W 3 credits 2G P. Burlando, S. Faticchi

Abstract

The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective

Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and
their modellisation with practical examples.

Content

Monitoring of hydrological systems (point and space monitoring, remote sensing). The use of GIS in hydrology (practical applications).
(components and processes). Example of modelling with the PRMS model. Calibration and validation of models. Flood routing (unsteady
flow, hydrologic routing, examples). The course contains an extensive semester project.

Lecture notes

Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project
consists of a two part instruction manual.

Literature

Additional literature is presented during the course.

102-0828-00L Ecology of Aquatic Ecosystems W 2 credits 2G U. Karaus

Abstract

Basics of limnology. Characteristics of chemistry, physics and biology of aquatic habitats. Interactions and adaptations of aquatic
organisms. Applied limnology including restoration of lakes and rivers. Excursions to lentic and lotic water habitats.

Objective

Principles in ecology. Case studies of aquatic ecosystems. Understanding the distribution patterns and adaptations of organisms due to
specific environmental factors of aquatic habitats.

Content

Limnology of lakes, ponds, springs and running waters. Aquatic communities and their structural and functional response to environmental
factors. Nutrient cycling and energy flow. Trophic interactions and food chain. Hazardous substances in Swiss lakes and rivers. Case
studies of Swiss restoration projects.

Excursions to lentic and lotic lake.

Lecture notes

handouts are provided

102-0317-00L Advanced Environmental Assessments W 3 credits 2G S. Hellweg, R. Frischknecht

Abstract

This course deepens students' knowledge of the environmental assessment methodologies and their various applications.

Objective

This course has the aim of deepening students' knowledge of the environmental assessment methodologies and their various applications.
In particular, students completing the course should have the
- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and
modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers

Content

- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multinput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

Lecture notes

No script. Lecture slides and literature will be made available.

Literature

Literature will be made available.

Prerequisites / notice

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic
before are required to read an appropriate textbook before or at the beginning of this course (e.g. Baumann&Tillman, The Hitch Hiker's

102-0327-00L Implementation of Environmental and other Sustainability Goals W 2 credits 1G A. E. Braunschweig

Objective

The goal of the course is to develop process-understanding of fluvial systems and to introduce the students to appropriate analysis tools.
In the first section the estimation of basin sediment supply from upland sheet, riff and gully erosion, and basin sediment yield are discussed.

Lecture notes

There is no script.

Literature

Study materials (lecture handouts and selected papers) are distributed in class and available on the web.

Prerequisites / notice

Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).
Basics and Principles of Radar Remote Sensing for Waste Recycling Technologies

We meet for five 3-hour-lectures, with discussions and case studies during course time. The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging. The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation.

Course documentation as well as case study descriptions will be provided during the course via the "Ilias" repository.

I. Hajnsek

A list of recommended books will be provided.

Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central Europe, it is only just now catching on in emerging markets as well.

Waste Recycling: Scope and objectives

- Separation Process
- Separation according to size and shape (Classification): Screening, Flow separation
- Separation according to material properties (Concentration): Manual Sorting, Gravity concentration; Magnetic separation, Eddy current separation, Electrostatic separation, Sensor technology, Froth flotation

Environmental Applications

- The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.
- The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation.
- At the end of the course the student has the understanding of SAR basics and principles, SAR polarimetry, SAR interferometry and environmental parameter estimation from multi-parametric SAR data
- The course covers an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:
  1. Introduction into SAR basics and principles
  2. Introduction into electromagnetic wave theory
  3. Introduction into scattering theory and decomposition techniques
  4. Introduction into SAR interferometry
  5. Introduction into polarimetric SAR interferometry
  6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

Lecture notes

Handouts for each topic will be provided.
Engineers are confronted every day with decision making under limited data and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However, the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. Therefore, risk analysis plays a key role in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

Literature

First readings for the course:
Complete literature listing will be provided during the course.

Prerequisites / notice

This course in combination with 102-0627-00-G: Applied Radar Remote Sensing for Environmental Parameter Estimation is providing a profound basis for independent data analysis. It is recommended to take both courses together.

**102-0627-00L Applied Radar Remote Sensing for Environmental Parameter Estimation**

**Objective**
The course is providing practical exercises for the use of Radar Remote Sensing, specifically Synthetic Aperture Radar (SAR) to estimate environmental parameters.

**Content**
The main focus of the course is the handling of multi-parameter SAR data for environmental parameter estimation with the following content:
1. Read and display multi-parametric SAR data
2. Application of different speckle filtering techniques
3. Derivation of the coherency and covariance matrix
4. Application of polarimetric correlation functions
5. Application of different decomposition techniques
6. Generation of a polarimetric SAR interferometry data set from a simulated forest
7. Processing of the polarimetric SAR interferometry data set
8. Estimation of environmental parameters (segmentation, soil moisture estimation, forest height estimation, etc.)

**Lecture notes**
Handouts for each topic will be provided.

**Literature**
First readings for the course:

**Prerequisites / notice**
This course in combination with 102-0627-00-G: Applied Radar Remote Sensing for Environmental Parameter Estimation is providing a profound basis for independent data analysis. It is recommended to take both courses together.

**101-0187-00L Structural Reliability and Risk Analysis**

**Objective**
The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.

**Content**
Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However, the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

**Prerequisites / notice**
Basic course on probability theory and statistics

**529-0047-00L Risk Assessment of Chemicals**

**Objective**
Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes: analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.

**Literature**


**Prerequisites / notice**

Fully prepared basis in probability theory and statistics
Projects on chemical assessment with the focus on the following aspects:

- Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
- Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
- Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
- Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
- Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Lecture notes
Project teaching; time frame totals ca. 80 hours.

Literature

Co-operation with chemical companies.

701-0423-00L Chemistry of Aquatic Systems W 3 credits 2G L. Winkel

Abstract
This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid-water interface, applications to lakes, rivers and groundwater.

Objective
Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters. Evaluation of analytical data from aquatic systems.

Content
Introduction to the chemistry of aquatic systems. Regulation of the composition of natural waters by chemical, geochemical and biological processes. Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.

Literature

529-0193-00L Renewable Energy Technologies I W 4 credits 3G A. Wokaun, A. Steinfeld

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste, CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Literature
- Hungerbühler, K.: Die Energiefrage (Vieweg, 2003);
- Kaltschmitt, M., Wiese, A., Streicher, W.: Erneuerbare Energien (Springer, 2003);

363-0387-00L Corporate Sustainability W 3 credits 2G V. Hoffmann

Abstract
We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and offer e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a group project, focusing on one of the four sustainability challenges of water, energy, mobility, and food.

Objective
Understand the limits and the potential of corporate sustainability for sustainable development

Content
Develop critical thinking skills that are useful for corporate sustainability (argumentation, communication, evaluative judgment)

Literature
- Heinloth, K.: Die Energiefrage (Vieweg, 2003);
- Kaltschmitt, M., Wiese, A., Streicher, W.: Erneuerbare Energien (Springer, 2003);

701-1543-00L Transdisciplinary Methods and Applications W 3 credits 2G P. Krüttli, M. Stauffacher

Abstract
This course offers e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a business environment. Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

Objective
Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

Content
- Critical thinking skills for corporate sustainability
- In-depth case study of concrete corporate sustainability challenge in the group project phase, such as: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze radical innovations for sustainability? How to invest money in a sustainable way?

Literature
Presentation slides will be distributed prior to lectures.

Project teaching; time frame totals ca. 80 hours.

Co-operation with chemical companies.
The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

**Objective**

At the end of the course students should:

- **Know:**
  - Function, purpose and algorithm of a selected number of transdisciplinary methods

- **Understand:**
  - Functional application in case studies and other problem oriented projects

- **Be able to reflect on:**
  - Potential, limits, and necessity of transdisciplinary methods

- **Be prepared for:**
  - Transdisciplinary Case Study 2016

**Content**

The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.

**Lecture notes**

Handouts are provided by the lecturers

**Literature**

Selected scientific articles and book-chapters

This course is recommended for students participating in the Transdisciplinary Case Study 2016.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>V+U</th>
<th>Instructor(s)</th>
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</thead>
<tbody>
<tr>
<td>701-1541-00L</td>
<td>Multivariate Methods</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>R. Hansmann</td>
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<td></td>
<td>One of the lectures 701-1541-00 (autumn semester) OR 752-2110-00 (spring semester) are highly recommended for students in Environmental Sciences with the Major Environmental systems and Policy.</td>
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<tr>
<td>Abstract</td>
<td>The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.</td>
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<tr>
<td>Objective</td>
<td>Upon completion of this course, the student should have acquired:</td>
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<td></td>
<td>(1) Knowledge on the foundations of several methods of multivariate data analysis, along with the conditions under which their use is appropriate</td>
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<td>(2) Skill in the estimation, specification and diagnostics of the various models</td>
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<td>(3) Hands-on experience with those methods through the use of appropriate software and actual data sets in the PC lab</td>
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<tr>
<td>Content</td>
<td>The course will begin with an introduction to multivariate statistical methods such as analysis of variance and multiple linear regression, where a metric dependent variable is &quot;explained&quot; by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.</td>
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<tr>
<td>Literature</td>
<td>Will be announced at the beginning of the course.</td>
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| 701-1551-00L | Sustainability Assessment                      | W | 3 credits | 2G | P. Krüttli, C. E. Pohl |
|              | The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability. |
| Abstract     | The course is seminar-like, interactive. |
| Objective    | At the end of the course students should |
|              | Know: |
|              | - core concepts of sustainable development, and; |
|              | - the concept of social justice - normatively and empirically - as a core element of social sustainability; |
|              | - important empirical methods for the analysis and assessment of local / regional sustainability issues. |
| Content      | The course is structured as follows: |
|              | - Overview of rationale, objectives, concepts and origins of sustainable development; |
|              | - Importance and application of sustainability in science, politics, society, and economy; |
|              | - Sustainable (local / regional) development in different national / international contexts; |
|              | - Analysis and evaluation methods of sustainable development with a focus on social justice; |
|              | - Tradeoffs in selected examples. |
| Literature   | Selected scientific articles & book-chapters |

| 851-0589-00L | Technology and Innovation for Development                  | W | 3 credits | 2V | P. Aerni |
|              | Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects. |
| Abstract     | The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects. |
| Objective    | - to recognize the challenges and opportunities of technological change in terms of sustainable development |
|              | - to become familiar with policy instruments to promote innovation |
|              | - to improve understanding of political decision-making processes in the regulation of science & technology |
|              | - improved understanding of the role of science and technology in the context of human and societal development |

**Prerequisites / notice**

This course is recommended for students participating in the Transdisciplinary Case Study 2016.
Content
Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies. The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological changes. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Lecture notes
Reader with issue-specific articles. E-version is partly available under http://www.ib.ethz.ch/teaching/material/stpp

Literature


Diamond, Jared. 2012. 'The World Until Yesterday; What Can We Learn from Traditional Societies?' New York: Viking.


Lecture notes
Lecture notes and slides

Prerequisites / notice
The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester. The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a selected article from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

701-0015-00L Seminar on Transdisciplinary Research for Sustainable Development
W 2 credits 2S C. E. Pohl, M. Stauffacher

Abstract
The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

Objective
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

Content
The seminar covers the following topics:
(1) Theories and concepts of inter- and transdisciplinary research
(2) The specific challenges of inter- and transdisciplinary research
(3) Involving stakeholders
(4) Collaborating disciplines
(5) Exploration of tools and methods
(6) Analysing participants' projects to improve inter- and transdisciplinary elements

701-0473-00L Weather Systems
W 3 credits 2G M. A. Sprenger, C. Grams

Abstract
This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

Objective
The students are able to:
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how mountains influence the atmospheric flow on different scales

Content
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes
Lecture notes and slides
The students learn to critically assess changes in land use management on element cycles in agroecosystems and to assess soil services based on soil mapping data. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus will be placed on soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.

Environmental Fluid Dynamics

Abstract
This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.

Objective
Students are able to:
- name the physical concepts of environmental fluid dynamics.
- understand and discuss the components of the basic physical equations in fluid dynamics.
- apply basic mathematical equations to simple problems of environmental fluid dynamics.

Content
Basic physical terminology and mathematical laws:
- Continuity hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on the rotating earth.
- Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems.
- Scale analysis: dimensionless variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.
- Waves in environmental fluid systems.

Lecture notes
In English language

Literature
Will be presented in class. See also: web-site.

Biogeochemistry of Trace Elements

Abstract
The course addresses major biogeochemical processes that drive the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.

Objective
The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.

Content
The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.

Lecture notes
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Prerequisites / notice
Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

Element Balancing and Soil Functions in Managed Ecosystems

Abstract
Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

Objective
The students learn to critically assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.

Content
The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus will be placed on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.

Lecture notes
Literature and Exercises for a case study

Prerequisites / notice
Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

River Engineering

Abstract
Main subjects treated:
- Fundamentals (e.g. sediment sampling methods), alluvial channel hydraulics, incipient motion, bed forms, bed load and suspended load, sediment budget and morphological changes, river morphology, scour, river management concepts and selected measures (e.g. bank and bed protection works).
- A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.

Objective
The students shall:
- be able to describe quantitatively the interrelation between discharge, sediment transport and channel evolution.
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration.

Content
The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, of bed load and suspended load transport are treated.

In the second part of the lecture the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of bed forms, river morphology and scour.

The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics treated are the stabilization of banks and of the longitudinal profile of rivers.

Lecture notes
Autography River Engineering (in German)

Literature
The autography contains a comprehensive list of references to relevant literature.
The voluntary and unmarked exercise bases on field data, which are collected by the students on a river in nature. Besides the collection of fundamental and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges at the onset of bed load transport and bed erosion and of the annual sediment load in a given river reach.

**102-0337-00L** Landfilling, Contaminated Sites and Radioactive Waste Repositories  
**W** 3 credits 2G  
**W. Hummel, L. M. Plötze**

**Abstract**  
Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

**Objective**  
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

**Content**  
This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity, mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

**Literature**  
Short script plus copies of overheads

**Hand-outs of lecture material with extended comments will be made available along with the lecture.**

**Prerequisites / notice**  
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

**151-0709-00L** Stochastic Methods for Engineers and Natural Scientists  
**W** 4 credits 3G  
**D. W. Meyer-Massetti**

**Abstract**  
The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and subsurface flows. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications.

**Objective**  
By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.

**Content**  
- Probability theory, single and multiple random variables, mappings of random variables
- Stochastic differential equations, Ito calculus, PDF evolution equations
- Polynomial chaos and other expansion methods
- All topics are illustrated with application examples from engineering.

**Literature**  
Some textbooks related to the material covered in the course:

**Hand-outs of lecture material with extended comments will be made available along with the lecture.**

**Prerequisites / notice**  
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

**102-0377-00L** Air Pollution Modeling and Chemistry  
**W** 3 credits 2G  
**S. Henne, A. C. Gerecke**

**Abstract**  
Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water).

**Objective**  
The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.

**Content**  
- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

**Literature**  
Lists of suitable books and papers will be provided in the lecture.

**Hand-outs of lecture material with extended comments will be made available along with the lecture.**

**Prerequisites / notice**  
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

**701-0535-00L** Environmental Soil Physics/Vadose Zone Hydrology  
**W** 3 credits 2G+2U  
**D. Or**

**Abstract**  
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

**Objective**  
Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
Skript "Lärmbekämpfung" erhältlich zu Beginn der Vorlesung.

The students will understand the basics of noise abatement: acoustics, impact of noise, measurement techniques and legislation. The

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media  Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow: unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester) http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

102-0317-01L Advanced Environmental Assessment (Computer Lab and Exercises) W 3 credits 2U+2P S. Pfister

102-0317-01 Advanced Environmental Assessments (Exercises) (2KP) and 102-0317-02 Advanced Environmental Assessment (Lab) (2KP) cannot be chosen if 102-0307-00 Advanced Environmental, Social and Economic Assessments (6KP) is selected. 102-0317-01 and 102-0317-02 are already included in 102-0307-00.

Abstract

Technical systems are investigated in projects with numerical modeling. The students learn how to answer given questions with target oriented methodologies using various software programs for environmental assessment.

Objective

Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modelling, Material Flow Analysis.

Minors Limited to 6 KP Totaly

Number Title Type ECTS Hours Lecturers

102-0535-00L Noise Abatement W 5 credits 4G K. Eggenschwiler, J. M. Wunderli

Abstract


Objective

The students will understand the basics of noise abatement: acoustics, impact of noise, measurement techniques and legislation. The students will be able to analyze different noise problems and they will be able to solve simple problems of noise abatement.

Content

Physikalische Grundlagen: Schalldruck, Wellen, Quellenarten.

Akustische Messtechnik: Umgang mit Dezibel, Akustische Masse, Schallpegelmesser, Spektralanalyse.

Lärmwirkungen: Gehör, Gesundheitliche Wirkungen von Lärm, Störung/Belästigung, Belastungsmasse.


Kurze Einführung in die Bauakustik und in die einfachsten Grundlagen der Raumakustik.


Lecture notes

Skript "Lärmbekämpfung" erhältlich zu Beginn der Vorlesung.


The basics of wastewater hydraulics are described from the environmental and the hydraulic points of views thereby presenting also
decompositions and the choking of a sewer as the abrupt transition from free-surface to pressurized high-speed flow are highlighted.


Exhaustive references are contained in the 'scripts'.

Visit of VAW hydraulic laboratories to add to applied resources. Description of a number of selected, at the time available hydraulic models.

Dr. R. Hermanns Stengele, Dr. M. Plötze: Environmental Geotechnics (german) digital

3. Semester

Project Work

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>102-0199-01L</td>
<td>Project on Water Resources Management</td>
<td>W</td>
<td>12</td>
<td>24A</td>
<td>Lecturers</td>
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<tr>
<td>Abstract</td>
<td>Working during one semester on a task on Water Resources Management</td>
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<tr>
<td>Content</td>
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<td>Project on Urban Water Management</td>
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<td>102-0399-01L</td>
<td>Project on Ecological Systems Design, Air Quality Control and Waste Management</td>
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<td>Working during one semester on a task on Material Flow and Waste Management</td>
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<td>102-0499-01L</td>
<td>Project on Soil Protection</td>
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<td>12</td>
<td>24A</td>
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<td>102-0599-01L</td>
<td>Project on Hydraulic Engineering</td>
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<td>Abstract</td>
<td>Working on a concrete task in Hydraulic Engineering</td>
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Practical Work Experience

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<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>102-0003-00L</td>
<td>External Professional Training</td>
<td>O</td>
<td>16</td>
<td></td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>External professional training according to a special regulation. The compulsory professional training lasts for at least 12 weeks and is a precondition to be allowed to write up the Master thesis, and to acquire the Master degree.</td>
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<tr>
<td>Objective</td>
<td>Experience how environmentally friendly solutions are reached in praxis.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Das Reglement für das obligatorische Berufspraktikum im Masterstudiengang Umweltingenieurwissenschaften kann heruntergeladen werden unter: <a href="http://www.umwelting.ethz.ch/download/Praktregl_MSc_Umwelting.pdf">http://www.umwelting.ethz.ch/download/Praktregl_MSc_Umwelting.pdf</a></td>
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</table>

Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Electives ETH Zürich

Course Catalogue of ETH Zurich

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-BAUG.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>102-0010-00L</td>
<td>Master’s Thesis in Water Resources Management</td>
<td>W</td>
<td>24</td>
<td>47D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract

The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

Objective

To work independently and to produce a scientifically structured work.

Content

The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

### Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
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<tr>
<th>Number</th>
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<td>Hydraulics I</td>
<td>E-</td>
<td>5</td>
<td>11R</td>
<td>M. Holzner</td>
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<tr>
<td>102-0214-AAL</td>
<td>Introduction to Urban Water Management</td>
<td>E-</td>
<td>6</td>
<td>4R</td>
<td>E. Morgenroth, M. Maurer</td>
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Abstract

The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.

Objective

Familiarization with the basics of hydromechanics of steady state flows

Content

Properties of water, hydrostatics, continuity, Euler equation of motion, Navier Stokes equation, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids-real fluids, boundary layer, pipe flow, open channel flow, flow in porous media, flow measurements, demonstration experiments in the lecture hall and in the laboratory

Lecture notes

Script and collection of problems available

Literature

Bollrich, Technische Hydromechanik 1, Verlag Bauwesen, Berlin

Introduce urban water management (water supply, urban drainage, wastewater treatment, sewage sludge treatment). Introduction to Urban Water Management is a self-study course.
This course provides an introduction and an overview of the topics of urban water management (water supply, urban drainage, wastewater treatment, sewage sludge treatment). It supports the understanding of the interactions of the relevant technical and natural systems. Simple design models are introduced.

Overview over the field of urban water management.

Introduction into systems analysis.

Characterization of water and water quality.

Requirement of drinking water, production of wastewater and pollutants

Production and supply of drinking water.

Urban drainage, treatment of combined sewer overflow.

Wastewater treatment, nutrient elimination, sludge handling.

Planning of urban water infrastructure.

Water Supply and Pollution Control. 8th edition (2009).

By: Warren Viessman, Jr., Mark J. Hammer, Elizabeth M. Perez and Paul A. Chadik.

Pearson Prentice Hall, Upper Saddle River, NJ.


Students must understand and be able to discuss the required reading in a 30 min oral exam. The required reading is explained in detail on the website of the professorships of urban water management. Additional information can be asked during the office hours of the professors' assistants.

Some students joining the MSc program in Environmental Engineering at ETH Zürich have to take additional courses from our BSc program. The decision of what courses to take is done at the time of admission at ETH.

The course on “Introduction to Urban Water Management” is offered at ETH Zürich only in German. Students who can speak and understand German must take the course (Siedlungswasserwirtschaft GZ) and get a passing grade. For students that do not have sufficient German language skills there is a self-study course and they have to take an oral exam.

This course is required for further in depth courses in urban water management.

Prerequisite: Hydraulics I and Hydrology

Ecological Systems Analysis

Enrolment only for MSc students who need this course as additional admission requirement.

Methodological basics and application of various environmental assessment tools.

Students learn about environmental assessment tools, such as material flow analysis, risk assessment, and life cycle assessment. They can identify and apply the appropriate tool in a given situation. Also, they are able to critically assess existing studies.

Application of these methods to case studies

No script, but literature available on homepage.

Literature available on


None

Waste Management

Enrolment only for MSc students who need this course as additional admission requirement.

Introduction into the problems of waste handling with the goal to get the ability of seeing and improving the influence of commodities and products with there packaging to the environment - as they are becoming waste. Knowing the different mechanical and chemical processes, which are applicable in the field of waste management.

*To know the problems of a modern waste management (C4)

*To see and to improve the influence of commodities and products to the environment (C5)

*To recognize waste and its components as raw material and resources and to get the know how for a correct handling (C6)

*To know the different mechanical and chemical processes, which are applicable in the field of waste management (C6)

This lecture gives a comprehensive overview of the different waste-types and waste handling possibilities:

*Waste composition as a mirror of the human evolution

*Waste definition (formation, amount, energy content, waste composition)

*Several recycling possibilities and processes

*Thermal waste treatment (electricity/district heat as products), including off-gas cleaning and incineration residue handling with regards to the final residue storage in a landfill and the problems which have to be solved there

*Special fields like biological waste handling (composting, fermentation), handling of special wastes and municipal sewage sludge treatment

*Economical aspects

Siehe englische Ausgabe

see bibliographie in the script

basic of chemical processes has to be known

Groundwater I

Enrolment only for MSc students who need this course as additional admission requirement.

The course provides an introduction into quantitativve analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.
**Objective**

a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

**Content**

Introduction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.

Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.

Flow equations, stream function.

Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.

Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.

Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.

Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.

Exercises: Finite difference formulations to flow problems.

Transport processes.

Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.

Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.

Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.

Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.

Exercises: Groundwater remediation.

Lecture notes

Folie auf Internet unter www.ihw.ethz.ch/GWH/education/index

Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index

Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index

Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature


W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995

Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970

G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

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**102-0635-AAL**

**Air Pollution Control**

Enrolment only for MSc students who need this course as additional admission requirement.

**Abstract**

The lecture provides an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and the impact on air quality. Theoretical description and modeling of these processes, air quality measurement techniques and pollution control techniques are covered.

**Objective**

The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost.

**Content**

- the physical and chemical processes leading to emission of pollutants
- air quality analysis
- the meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- measurement concepts to observe ambient air pollution
- removal of gaseous pollutants by absorption and adsorption
- control of NOx and SOx
- fundamentals of particulate control
- design and application of wet scrubbers

**Literature**

Text book


**Prerequisites / notice**

College lectures on basic physics, chemistry and mathematics.

---

**102-0474-AAL**

**Introduction to Water Resources Management**

Enrolment only for MSc students who need this course as additional admission requirement.
The course offers an introduction to the basics of water resources analysis and management covering the topics of water demand vs. availability, water exploitation and reservoir design, aquatic physics, water quality and pollution, water conservation and remediation in rivers, lakes and aquifers, sustainable water use.

### Objective

Introduction to the basics of water resources management based on physical and chemical processes; principle of sustainability

### Content


Wassergüte: Anforderungen, Schadstoffausbreitung, Selbstreinigung, Thermische Belastung, relevante Schadstoffe und Quellen, Stossbelastungen, Zeitkonstanten und Grössenordnungen.

Wasserwirtschaft: Struktur von Dargebot und Nachfrage.

Optimierung zur Schliessung der Disparität: Reservoire, Grundwasserspeicher, Überleitungen, Wasserwirtschaftliche Rahmenplanung (Masterplan) Gewässerschutz, Sanierung und Renaturierung (Oberflächengewässer und Grundwasser), Variabilität, Stochastik und Risiko.

Nachhaltigkeit: Definitionen, Beispiele für nicht-nachhaltiges Wirtschaften, Wasserprobleme der Entwicklungsländer, Wasser und Landwirtschaft, Projektbewertung und Umweltverträglichkeitsprüfung. Ökonomische und Soziologische Bezüge.

Alle Aspekte sollen mit Fallbeispielen illustriert werden.


### Lecture notes

Script in wöchentlichen Folgen.

---

### Computer Science II

**Course Code:** 525-0846-AAL  **Credit:** 4  **Type:** F. O. Friedrich

**Objective**

Enrolment only for MSc students who need this course as additional admission requirement.

**Abstract**

Introduction to programming in Java. Procedural foundations of programming and outlook to object oriented programming. Variables, types, assignments, control structures (branch, loop), data structures, algorithms, line graphics, graphical user interface. Writing small programs. Working with a professional programming environment (Eclipse).

**Content**

The students will be able to write simple programs and to modify existing programs.

This course offers an introduction to variables, control structures (branch, loop), algorithms and data structures, as well as an outlook to modularisation and object oriented techniques.

In the exercises students train programming skills (in the programming language JAVA). Students can solve the exercises on their own laptop or in the computer labs at ETH. The software used in this course runs on MS Windows, MacOS X and Linux.

**Prerequisites**

- Prerequisites: 252-0845-00 Computer Science I (D-BAUG)

---

### Chemistry I and II

**Course Code:** 529-2001-AAL  **Credit:** 9  **Type:** H. Grützmacher, W. Uhlig

**Objective**

Enrolment only for MSc students who need this course as additional admission requirement.

**Abstract**

General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry

**Content**

1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)
7. Electrochemistry

**Literature**

- Nivaldo J. Tro, Chemistry - A molecular Approach (Pearson), Chapter 1-18
- Housecroft and Constable, CHEMISTRY
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY

---

### Chemistry II

**Course Code:** 529-2002-AAL  **Credit:** 5  **Type:** H. Grützmacher, W. Uhlig

**Objective**

Enrolment only for MSc students who need this course as additional admission requirement.

**Abstract**

Chemistry II: Redox reactions, chemistry of the elements, introduction to organic chemistry

**Content**

1. Redox reactions
2. Inorganic Chemistry
3. Introduction to organic chemistry

**Lecture notes**

### Hydrology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0255-AAL</td>
<td>Hydrology</td>
<td>2 credits</td>
<td>E-</td>
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<tr>
<td>752-4001-AAL</td>
<td>Microbiology</td>
<td>2 credits</td>
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<td>102-0293-AAL</td>
<td>Hydrology</td>
<td>3 credits</td>
<td>E-</td>
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</table>

**Abstract**

- Introduction to basic biochemistry and the most important metabolic reactions.
- Based on the biology and chemistry courses in the 1. and 2. semester more detailed biochemical knowledge about enzymology, membrane biochemistry, and central metabolism will be presented.

**Objective**

Program

- Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
- Structure and function of proteins
- Carbohydrates, structure of DNA
- Lipids an biological membranes
- Enzymes and enzyme kinetics
- Catalytic strategies
- Metabolism: Basic concepts and design. Repetition of basic thermodynamics
- Glycolysis
- The citric acid cycle
- Oxidative phosphorylation
- Fatty acid metabolism

**Lecture notes**

by Laurence A. Moran (Author), Robert A Horton (Author), Gray Scrimgeour (Author), Marc Perry (Author)

**Literature**

  by Laurence A. Moran (Author), Robert A Horton (Author), Gray Scrimgeour (Author), Marc Perry (Author)

**Prerequisites / notice**

Basic knowledge in biology and chemistry is a precondition.

---

**Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry**

- Structure and function of proteins
- Carbohydrates, structure of DNA
- Lipids an biological membranes
- Enzymes and enzyme kinetics
- Catalytic strategies
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**Prerequisites / notice**

Basic knowledge in biology and chemistry is a precondition.
Prerequisites / notice

Vorbereitend zu Hydrologie I sind die Vorlesungen in Statistik. Der Inhalt, der um ein Teil der Übungen zu behandeln und um ein Teil der Vorlesungen zu verstehen notwendig ist, kann zusammengefasst werden, wie hintereinander es beschrieben wird:

Elementare Datenverarbeitung: Hydrologische Messungen und Daten, Datenreduzierung (grafische Darstellungen und numerische Kenngrößen).


Environmental Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
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<tr>
<td>O</td>
<td>Compulsory</td>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
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<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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Key for Hours

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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Educational Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs “Teaching Diploma” or “Teaching Certificate”. It is about learning in childhood and adolescence.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>Thematische Schwerpunkte: Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfer; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<td><strong>Lecture notes</strong></td>
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<td>Folien werden zur Verfügung gestellt.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs &quot;Lehrdiplom&quot; or &quot;Didaktisches Zertifikat&quot;. It is about learning in childhood and adolescence.</td>
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<tbody>
<tr>
<td>851-0242-05L</td>
<td>Cognitively Activating Instructions in MINT Subjects ■ W</td>
<td></td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td>- Get information about recent literature on learning and instruction</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence ■ W Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td>- Getting to know intelligence tests</td>
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<td></td>
<td>- Understanding findings relevant for education</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science ■ W Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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<tr>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W DZ) ■ W</td>
<td></td>
<td>2 credits</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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</tbody>
</table>
The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Abstract
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching.

Objective
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

1. They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
2. They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0823-00L</td>
<td>Environmental Education Didactics I</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>C. Colberg, F. Keller</td>
</tr>
</tbody>
</table>

Abstract
Environmental Education Didactics supplies the basic concepts for the application of the contents of the lecture Human Learning (EW 1) in environmental education.

Objective
Application of the principles and topics of education sciences on environmental contexts.

Content

Lecture notes
Die Unterlagen zu den behandelten Themen werden über den BSCW-Server abgegeben (Anmeldung obligatorisch).

701-0827-00L | Teaching Internship Including Examination Lessons Environmental Studies | O    | 6 credits | 13P | C. Colberg, F. Keller |

Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content
The students will be able to watch and evaluate the teaching of colleagues and experts. They get profit out of their teaching experiences not only when preparing but also when teaching. Doing so they will be supported by their mentors.

Lecture notes
Dokumente unter http://www.didaktische-ausbildung.ethz.ch/docs/uwis
- Raster zum Bericht über das Unterrichtspraktikum im DZ Umweltlehre an der ETH Zürich (PDF)
- Beurteilungsbogen Prüfungslektionen Umweltlehre unter: http://www.didaktische-ausbildung.ethz.ch/docs/index:
- Schriftliche Unterrichtsvorbereitung für Prüfungslektionen (PDF)

Literature
Wird von der Praktikumslehrperson bestimmt.

Environmental Studies TC - Key for Type

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<tr>
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<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
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</tr>
<tr>
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<td>Recommended, not eligible for credits</td>
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<td>Z</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

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<td>lecture with exercise</td>
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ECTS European Credit Transfer and Accumulation System

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<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
</tbody>
</table>

Abstract
General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

Objective
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

Content
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

Lecture notes
ca. 360 Seiten mit vielen Figuren und durchgerechneten Beispielen.

Literature
- Brown, LeMay, Bursten CHEMIE (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0251-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>A. Cannas da Silva</td>
</tr>
</tbody>
</table>

Abstract
This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

Objective
Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

Content
1. Single-Variable Calculus:
   - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.
2. Linear Algebra and Complex Numbers:
   - systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvales and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.
3. Ordinary Differential Equations:
   - separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

Literature
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).
- Brown, LeMay, Bursten CHEMIE (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

Prerequisites / notice
Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

Assistance:
Mondays 12-13, Tuesdays 17-19, Wednesdays 17-19, in Room HG E 41.

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<tr>
<td>701-0757-00L</td>
<td>Principles of Economics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>R. Schubert</td>
</tr>
</tbody>
</table>

Abstract
This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.

Objective
Students are able to
- describe fundamental micro- and macroeconomic issues and theories.
- apply suitable economic arguments to a given theme.
- evaluate economic measures.

Content
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomic policies

Lecture notes
available on electronic platform

Literature


Prerequisites / notice
generally not required

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0005-00L</td>
<td>Introduction to the Handling of Environmental Systems</td>
<td>O</td>
<td>5</td>
<td>1G+4S</td>
<td>P. M. Frischknecht, H. R. Heinimann, B. T. Schmied, N. Dajcar, C. E. Pohl</td>
</tr>
</tbody>
</table>

Abstract
Imparting basic understanding of systematical problem-solving and target-oriented process presentations. Introduction of methods for working out environmentally relevant problems. Practical application of theoretical knowledge on a case study on renewable energy. Practice of communication skills, especially of writing a scientific report.
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the

- Dimensions of a Problem/Case Strategie (Logik, Prozesse, Sache)
- Problemposing, Entwurfs- und Entwicklungsstrategien
- Managementkonzeptionen am Beispiel Projektmanagement
- Modelle der Prozessgestaltungs- und -steuerung
- Kooperation im Rahmen von Gruppen und Teams (Projektleitung, Teammoderation, Grouppewarkeonzepte, interaktive elektronische Kommunikationskonzepte)

Im theoretischen Teil des Seminars "E in den Umgang mit Umweltsystemen" geht es um die Schwerpunkte:
- Techniken und Methoden zur Bearbeitung von naturwissenschaftlichen, juristischen, akteurbezogenen sowie ökonomischen Aspekten von
  komplexen umweltrelevanten Problemstellungen.
- Techniken der Ziel- und Massnahmenfindung sowie der Bewertung.
- Wie schreibe ich einen wissenschaftlichen Bericht.

Bei der Bearbeitung eines konkreten Falles soll:
- Das theoretische Wissen mit Unterstützung von Expertinnen und Experten am Rande werden.
- Zu einem Teilbereich ein wissenschaftlicher Bericht geschrieben werden.
- Eine Methode der Wissensintegration angewandt werden.
- Auf eine strategische Planung ausgerichtete Massnahmen entwickelt werden.
- Die gewonnenen Erkenntnisse Kolleginnen und Kollegen sowie den am Fall beteiligten Akteuren in Form von schriftlichen Berichten und
  Vorträgen präsentiert werden.

Lecture notes
Abgabe ausgewählter Literatur zum Fall
Abgabe eines Skripts

Literature
Abgabe einer Fall bezogenen Literaturliste

Prerequisites / notice
Die Lehrveranstaltung beinhaltet neben einer Auskursion auch verschiedene Gruppensitzungen sowie ein Blockseminar.

551-0001-00L General Biology I O 3 credits 3V U. Sauer, A. Widmer

Abstract
Basics of structure, formation and function of cells and biomacromolecules, principles of metabolism, as well as basic classical and
molecular genetics and evolutionary biology. First in a series of two lectures given over two semesters for students of agricultural and food
sciences, as well as of environmental sciences.

Objective
The understanding of some basic principles of biology: the hierarchy of the structural levels of biological organisation, with particular
emphasis on the cell and its functions, as well as metabolism, inheritance and evolution.

Content
The structure and function of biomacromolecules; basics of metabolism; cell biology; membrane structure and function; basic energetics of
cellular processes; respiration, photosynthesis; cell cycle, meiosis and sexual life cycles; Mendelian and molecular genetics; animal
reproduction and behavior; sensory and motor mechanisms; population biology and evolution; principles of phylogeny.

The Campbell Chapters 1-4 (10th edition) under the heading "The role of chemistry in biology" are expected. We will treat the following
Campbell chapters:

5 Biochemistry Biological Macromolecules and Lipids
7 Cell biology Cell Structure and Function
8 Cell biology Cell Membranes
10 Cell biology Cellular Respiration: An Introduction to Metabolism
10 Cell biology Cellular Respiration
11 Cell biology Photosynthesis
12 Cell Biology Mitosis
13 The Genetic Basis of Life Sexual Life Cycles and Meiosis
14 The Genetic Basis of Life Mendelian Genetics
15 The Genetic Basis of Life Linkage and Chromosomes
20 The Genetic Basis of Life The Evolution of Genomes
21 Evolution How Evolution Works
22 Evolution Phylogeographic Reconstruction
23 Evolution Microevolution
24 Evolution Species and Speciation
25 Evolution Macroevolution

Lecture notes
no script

Literature

Prerequisites / notice
The lecture is the first in a series of two lectures given over two semesters for students with biology as a basic subject.


Abstract
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in
ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems; corresponding methodological
approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

Objective
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the
individual, the population, the community and the ecosystem level.

The students should learn ecological concepts at these different levels in the context of concrete examples from terrestrial and aquatic
ecology. Corresponding methods for studying the systems will be presented.

A further aim of the lecture is that students achieve an understanding of biodiversity, why it is threatened and how it can be managed.

Content
- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte
  Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflüsse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Laboratory Course: Elementary Chemical Techniques

Abstract
This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.

Objective
This course is intended to provide an overview of experimental chemical methods. The handling of chemicals and proper laboratory techniques represent the main learning targets. Furthermore, the description and recording of laboratory processes is an essential part of this course.

Literature

Further information:
https://moodle-app2.let.ethz.ch/course/info.php?id=1682

Additional First Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>L. E. Fassler, H.J. Böckenhauer, M. Dahinden, D. Kottm</td>
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<tr>
<td>529-0030-00L</td>
<td>Laboratory Course: Elementary Chemical Techniques</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>N. Kobert, M. Morbidelli</td>
</tr>
</tbody>
</table>

Prerequisites / notice
All materials for the course are available at www.evim.ethz.ch

The students spend most of their time working through electronic tutorials and discussing their results with teaching assistants.
The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:

Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvatation or precipitation processes) is studied.

The synthesis of simple inorganic complexes or organic molecules is practised.

Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

The script will be published on the web.

Details will be provided on the first day of the semester.

A thorough study of all script materials is requested before the course starts.

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<thead>
<tr>
<th>Number</th>
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<tr>
<td>751-0801-00L</td>
<td>Biology I: Laboratory Exercises</td>
<td>O</td>
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<td>Principles and methods of light microscopy</td>
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<td>Preparation of specimen for microscopy</td>
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<td>Documentation. Anatomy of seed plants:</td>
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<td>From cells to organs. Special features of</td>
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<td>plant cells. Anatomy and function of</td>
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<td>plant organs. Anatomical adaptations to</td>
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<td>different environments.</td>
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<td>Basics of optics. Principles of light</td>
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<td>microscopy. Microscope parts and their</td>
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<td>function. Köhler illumination. Optical</td>
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<td>sizes with the microscope. Preparation</td>
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<td>tissue staining techniques. Special</td>
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<td>features of plant cells: Plastids,</td>
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<td>vacuole, cell wall. Anatomy of seed</td>
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<td>plants: From cells to organs. Anatomy</td>
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<td>and function of various plant tissues:</td>
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<td>(epidermis, vascular tissue, wood, etc.).</td>
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<td>Anatomy and function of different plant</td>
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<td>organs (root, stem, leaf, flower, seed).</td>
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<td>Anatomical adaptations to different</td>
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<td>environments.</td>
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<td>For further reading (not obligatory):</td>
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<tr>
<td></td>
<td>Gerhard Wanner: Mikroskopisch-Botanisches</td>
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<tr>
<td></td>
<td>Praktikum, Georg Thieme Verlag, Stuttgart.</td>
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<td>Prerequisites</td>
<td>Groups of a maximum of 30 students.</td>
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<tr>
<td>752-4001-00L</td>
<td>Microbiology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. Ackermann, M. Schupper,</td>
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<td></td>
<td>Molecular Genetics, Microbial Growth,</td>
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<td>J. Vorholt-Zambelli</td>
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<td></td>
<td>Metabolic Diversity, Phygology and</td>
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<td></td>
<td>Taxonomy, Prokaryotic Diversity,</td>
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<td>Human-Microbe Interactions, Biotechnology.</td>
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<td></td>
<td>Teaching of basic knowledge in microbiology</td>
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<td>with main focus on Microbial Cell Structure</td>
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<td>and Function.</td>
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<tr>
<td></td>
<td>biology, Molecular Genetics, Microbial</td>
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<td>Growth, Metabolic Diversity, Phygology and</td>
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<td>Human-Microbe Interactions, Biotechnology.</td>
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<td></td>
<td>Der Schwerpunkt liegt auf den Themen:</td>
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<tr>
<td>Literature</td>
<td>Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms</td>
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<tr>
<td>Prerequisites</td>
<td>Wird von den jeweiligen Dozenten ausgegeben.</td>
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<tr>
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<tbody>
<tr>
<td>701-0255-00L</td>
<td>Biochemistry</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>H.P. Kohler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Building on the biology courses in the 1st</td>
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<td>and 2nd semesters, this course covers</td>
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<td></td>
<td>basic biochemical knowledge in the areas</td>
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<td>of enzymology and metabolism. Those</td>
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<td>completing the course are able to describe</td>
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<td>and understand fundamental cellular</td>
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<td></td>
<td>metabolic processes.</td>
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</tbody>
</table>
Students are able to understand
- the structure and function of biological macromolecules
- the kinetic bases of enzyme reactions
- thermodynamic and mechanistic basics of relevant metabolic processes

Students are able to describe the relevant metabolic reactions in detail

This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

The case studies and the analysis of the questions and problems are integral part of the course.

Textbook: Evolutionary Analysis
Scott Freeman and Jon Herron

The exam is based on lecture and textbook.

## Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0023-00L</td>
<td>Atmosphere</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>H. Wernli, T. Peter</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.</td>
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<tr>
<td>Objective</td>
<td>Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphère.</td>
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<tr>
<td>Content</td>
<td>Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.</td>
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<tr>
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<td>Written information will be supplied.</td>
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<tr>
<td>701-0401-00L</td>
<td>Hydrosphere</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>P. Bayer, R. Kipfer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.</td>
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<tr>
<td>Objective</td>
<td>Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.</td>
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<tr>
<td>Content</td>
<td>Topics of the course. Physical properties of water (i.e. density and equation of state) - global water resources - Exchange at boundaries - energy (thermal &amp; kinetic), gas exchange Mixing and transport processes in open waters - vertical stratification, large scale transport - turbulence and mixing - mixing and exchange processes in rivers Groundwater and its dynamics - ground water as part of the terrestrial water cycle - ground water hydraulics, Darcy's law - aquifers and their properties - hydrochemistry and tracer - ground water use Case studies - 1. Water as resource, 2. Water and climate</td>
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<tr>
<td>Lecture notes</td>
<td>In addition to the suggested literature handouts are distributed.</td>
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<tr>
<td>Literature</td>
<td>Suggested literature.</td>
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<tr>
<td>701-0501-00L</td>
<td>Pedosphere</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>R. Kretzschmar</td>
</tr>
<tr>
<td>Abstract</td>
<td>Physical properties of soil (i.e. density and equation of state) - organic and inorganic composition - Exchange at boundaries - Electrical conductivity - mixing and transport processes in open waters - vertical stratification, large scale transport - turbulence and mixing - mixing and exchange processes in open waters Groundwater and its dynamics - ground water as part of the terrestrial water cycle - ground water hydraulics, Darcy's law - Rivers and their properties Hydrosphere - tropical river systems</td>
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<tr>
<td>Objective</td>
<td>Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.</td>
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<tr>
<td>Content</td>
<td>Topics of the course. Physical properties of soil (i.e. density and equation of state) - organic and inorganic composition - Exchange at boundaries - Electrical conductivity - mixing and transport processes in open waters - vertical stratification, large scale transport - turbulence and mixing - mixing and exchange processes in open waters Groundwater and its dynamics - ground water as part of the terrestrial water cycle - ground water hydraulics, Darcy's law - Rivers and their properties Hydrosphere - tropical river systems</td>
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<tr>
<td>Lecture notes</td>
<td>In addition to the suggested literature handouts are distributed.</td>
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<tr>
<td>Literature</td>
<td>Suggested literature.</td>
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</tbody>
</table>
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Objective**

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Content**

Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

**Lecture notes**

Lecture notes can be purchased during the first lecture (15.- SFr)

**Literature**


**Prerequisites / notice**

Prerequisites: Basic knowledge in chemistry, biology and geology.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0071-00L</td>
<td>Mathematics III: Systems Analysis</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>N. Gruber, P. Landschützer</td>
</tr>
</tbody>
</table>

**Abstract**

The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space.

**Objective**

Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.

**Content**

- Content of lectures: http://www.up.ethz.ch/education/system_analysis/index_DE
- Homework: http://www.up.ethz.ch/education/system_analysis/SA2/index_DE

**Homework:** http://www.up.ethz.ch/education/system_analysis/index_DE

**Additional Compulsory Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0033-00L</td>
<td>Laboratory Course in Physics for Students of Environmental Sciences</td>
<td>O</td>
<td>2</td>
<td></td>
<td>M. Männich, A. Biland, N. Gruber</td>
</tr>
</tbody>
</table>

**Abstract**

The course provides an individual experience of physical phenomena and the basic principles of experiments. By carrying out simple physical experiments the students learn the proper use measuring instruments, the correct evaluation of report of the measured data and how to interpret the final results.

**Objective**

This laboratory course aims to provide basic knowledge of - the setup of a physics experiment, - the use of measurement instruments, - various measuring techniques, - the analysis or measurement errors, - and the interpretations of the measured quantities.

**Content**

Fehlerrechnung, 8 ausgewählte Versuche, ein Seminarvortrag zu einem Versuch

Versuche:


**Lecture notes**

Manuals for the laboratory experiments are provided online.

**Prerequisites / notice**

Einführungsveranstaltungen:

- Block 1: Do. 17. 9. 2015, 9-12  (Raum noch offen)
- Block 2: Do. 29.10. 2015, 9-12  (Raum noch offen)

Moodle Kursseiten zum Praktikum https://moodle-app2.let.ethz.ch/course/view.php?id=1648

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0035-00L</td>
<td>Integrated Practical Observation Networks</td>
<td>O</td>
<td>1.5</td>
<td></td>
<td>B. Sierau, J. Henneberger, T. Tormann</td>
</tr>
</tbody>
</table>

**Abstract**

Observation networks - the combination of individual instruments - are the starting point of quantitative environmental studies. The structure and idiosyncrasies of existing observation networks are shown. When working in individual experiments on practical problems, various types of observation networks are dealt with; questions related to data quality and data availability are discussed.

**Objective**

Getting acquainted with existing networks. Insight into problems related to measuring and interpreting multi-dimensional fields of atmospheric physical, atmospheric chemical, and geophysical parameters.

**Content**

Observation networks for atmospheric physical, atmospheric chemical, geophysical, hydrological and climatological parameters on different scales (synoptic: 1000 km; mesoscale: 100 km, and microscale: 100 m). Combination of surface observation with remotely sensed data (satellite, radar). Solving interpolation problems in multi-dimensional fields of the observed variables. Assessing the representativity of local values, i.e., the directly observed variable in an observation network.

**Lecture notes**

The script is published anew every year. Apart from the description of the scientific problems to be worked on in individual experiments, it contains some theoretical chapters on observation networks, as well as guidelines for writing and publishing scientific papers. The script can be downloaded as pdf from the course webpage.

**Literature**

Literature is listed in the script.

**Social Sciences and Humanities Module**

**Module Economics**
Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0387-00L</td>
<td>Corporate Sustainability</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>V. Hoffmann</td>
</tr>
</tbody>
</table>

Abstract
We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and offer e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a group project, focusing on one of the four sustainability challenges of water, energy, mobility, and food.

Objective
Understand the limits and the potential of corporate sustainability for sustainable development

Develop critical thinking skills that are useful for corporate sustainability (argumentation, communication, evaluative judgment)

Be able to recognize and realize opportunities for corporate sustainability in a business environment

Content
Business implications of sustainable development, in particular for corporate strategy, marketing & leadership, technology & innovation, and financial markets.

Critical thinking skills for corporate sustainability

In-depth case study of concrete corporate sustainability challenge in the group project phase, such as: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze radical innovations for sustainability? How to invest money in a sustainable way?

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0763-00L</td>
<td>Basic Concepts of Management</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>R. Schwarzenbach</td>
</tr>
</tbody>
</table>

This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioners; e.g. will Mr. S. Baldenweg, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures.
Skripten werden elektronisch zur Verfügung gestellt.

An environmental management system has the objective to continuously improve the environmental performance of the activities, products and services of a company. The company has to introduce different management procedures. The goal of this lecture is to provide basics and specific procedure to implement the environmental dimension in the planning and decision making processes of an organisation.

Die finanzielle Abbildung von Organisationen und Projekten wird übersichtsweise dargestellt und die stufengerechte Darstellung von Informationen anhand von realen Beispielen besprochen.

Die Inhalte werden durchgängig mit Praxisbeispielen illustriert.

Lecture notes
Skripten werden elektronisch zur Verfügung gestellt.

Literature
Empfohlen werden folgende Titel für die Vertiefung einzelner Themen:


Prerequisites / notice
Deutsch

<table>
<thead>
<tr>
<th>151-0757-00L</th>
<th>Environmental Management</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>R. Züst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Overview on environmental management and environmental management systems, general methods and principles.</td>
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<tr>
<td>Content</td>
<td>Introduction to environmental management / environmental management systems, energy and material flows; economical and ecological problems in industry; characterisation of an enterprise (incl. management handbook); structure and contents of an environmental management system; overview on the ISO 14001 ff. series; methods for environmental evaluation and assessment; integrated management systems; planning methodology and life-cycle-design design; planning example</td>
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<tr>
<td>Lecture notes</td>
<td>Information about environmental management and environmental management systems will be provided by a CD or mail.</td>
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<tr>
<td>Literature</td>
<td>a list with literatures and links will be provided</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Delivery of a case study, worked out in groups. Language: Teaching in English on request.</td>
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<tbody>
<tr>
<td>Abstract</td>
<td>Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students’ technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.</td>
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<tr>
<td>Objective</td>
<td>Discovering Management offers an integrated learning system, which combines in an innovative format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves ‘learning by doing’. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, and 2) the business game simulation. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students’ understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility. Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.</td>
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</table>
### Content

The lectures for Discovering Management are designed to broaden the participant's understanding of the principles of entrepreneurial management, emphasizing the interdependence of various specialties in the development and management of a firm. For this reason, the lectures are structured on the basis of a coherent business model and will be presented by the respective area specialists at D-MTEC. The lectures broaden the view and the understanding of technology by interlinking it with society. Corporate sustainability, for example, introduces economic, ecological and social issues that are relevant to all engineering disciplines. Practical examples simulate the students to assess these issues and be aware of their responsibilities as engineers. Technology and innovation management, to mention a second example, focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students' ability to see the business and social consequences of their 'technical' decisions. Critical skills will be trained by the case study exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant's appreciation for the complex tasks companies deal with.

Discovering Management attempts to overcome the limitations of traditional teaching curricula of management in technical universities, which often merely focus on transferring specific skills to students, e.g. planning or forecasting. In response to the new challenges for entrepreneurial decision-making, students will be offered the opportunity to actively engage in an advanced business game simulation; a business game that establishes a link between business management theory and business management in practice. The simulation presents a realistic model of a company and provides participants with the opportunity to quickly gain the lasting effects of practical experience in a risk-free environment. All this provides a valuable learning platform to integrate the increasingly important development of the skills and competencies required to identify entrepreneurial opportunities, analyze the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

### Prerequisites / notice

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich.

No prior knowledge of business or economics is required to successfully complete this course.

### 351-0778-01L Discovering Management (Exercises)

<table>
<thead>
<tr>
<th>W</th>
<th>1 credit</th>
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<tr>
<td>1U</td>
<td>P. Frauenfelder</td>
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</table>

**Complementary exercises for the module Discovering Management.**

**Prerequisite:** Participation and successful completion of the module Discovering Management (351-0778-00L) is mandatory.

**Abstract**

This course is offered complementary to the basis course 351-0778-00L, "Discovering Management". The course offers additional exercises and case studies.

**Objective**

This course is offered to complement the course 351-0778-00L. The course offers additional exercises and case studies.

**Content**

The course offers additional exercises and case studies concerning Strategic Management; Technology and Innovation Management; Operations and Supply Chain Management; Finance and Accounting; Marketing and Sales.

Please refer to the course website for further information on the content, credit conditions and schedule of the module: www.dm.ethz.ch

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### 363-0503-00L Principles of Microeconomics

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<tr>
<td>2G</td>
<td>M. Filippini</td>
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</table>

**Objective**

The course introduces basic principles, problems and approaches of microeconomics.

**Content**

The course includes the following main topics:

- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

**Lecture notes**

Lecture notes, exercises and reference material can be downloaded from Moodle.

**Literature**

N. Gregory Mankiw and Mark P. Taylor (2014), "Economics", 3rd edition, South-Western Cengage Learning. The book can also be used for the course 'Principles of Microeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:


**Complementary:**


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### 751-1101-00L Finances and Accounting System

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<thead>
<tr>
<th>W</th>
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<tr>
<td>2G</td>
<td>M. Dumondel</td>
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</tbody>
</table>

**Objective**

To understand accounting as a component of the complex system of the enterprise.

**Content**

To understand accounting not as an isolated discipline, but as a part of the complex system of the enterprise.

**Lecture notes**

In the lecture one indicates

**Literature**

Course documentation and specified educational books

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### 751-1651-00L World Food Economy and Agricultural Markets

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<td>2V</td>
<td>R. Jörin</td>
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</table>

**Abstract**

Following microeconomic courses we teach in this course economic aspects of the world food situation and the international and national agricultural markets. It contains aspects of supply, demand, price determination, market structures and instruments of the agricultural trade.

**Objective**

Economic understanding of agricultural markets and the aspects of the world food problem.

**Content**

Part I: Principles of agricultural economics

Microeconomic analysis of supply, demand, and price determination in agricultural markets.

Part II: Aspects of globalization, development, natural resources and public health.

**Literature**

Southgate. D. et al., 2010. The World Food Economy, Blackwell Publishing, Malden MA,USA

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### 851-0626-01L International Aid and Development

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<tr>
<th>W</th>
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<tr>
<td>2V</td>
<td>I. Günther</td>
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</tbody>
</table>

**Prerequisites:** Basic knowledge of economics
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid. The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.

This course presents the basics of policy analysis and the specific characteristics of Swiss environmental policy. Political instruments, actors and processes are addressed both theoretically as well as by means of current Swiss environmental policy examples. Beyond acquiring basic knowledge about policy analysis, this course teaches students how to analytically address current and concrete questions of environmental policy. Through exercises the students learn about political science concepts and frameworks as well as real-life political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the (environmental policy) workforce or a future research career.

The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on social and political institutions. In the interplay between the environment, society and economy, the environmental policy field encompasses the sum of public measures that have the goal to eliminate, reduce or avoid environmental degradation. The course provides insight into the development of Swiss environmental policy and systematically presents the basics of environmental policy actors, instruments, programs and programs as well as their change over time. A key aspect is the distinction between politics and political science and specifically environmental policy.

Instead of lecture notes different texts on policy analysis and Swiss environmental policy are made available to the students. This course is based on the following textbook:


The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

This course covers the basics questions, concepts, theories, methods, and empirical findings of political science.

This course is based on the following textbook:


This course is based on the following textbook:


This course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

- Identify and appraise ecological aspects in development cooperation, development policies and developing countries’ realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions
Content

Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, and successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Diversitity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

Lecture notes

Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle)

Literature


Prerequisites / notice

The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

701-0731-00L Environmental Sociology

W 2 credits 2S H. Bruderer Enzier

Abstract

This introductory class in environmental sociology covers different theoretical approaches but the main focus is on recent empirical research on topics such as environmental behavior, environmental concern, social dilemmas, social norms, environmental justice, and risk perception.

Objective

Basic knowledge of environmental sociology
Overview on current fields of research in environmental sociology and their relevance for environmental protection
Basic notion of the structure of empirical research papers in social sciences

Content

Das Seminar führt in die Umweltsoziologie ein. Dabei werden verschiedene theoretische Ansätze besprochen (Fokus: Rational Choice). Der Schwerpunkt des Kurses liegt auf aktuellen empirischen Untersuchungen zu Themen wie Umweltverhalten, Umweltbewusstsein, soziale Dilemmata, soziale Normen, Umweltgerechtigkeit und Risikowahrnehmung.

Fragen, die uns dabei beispielsweise beschäftigen: Wer belastet die Umwelt besonders stark oder ist besonders starken Umweltbelastungen ausgesetzt? Was beeinflusst das Umweltverhalten der Menschen? Welche Rolle spielen äussere Faktoren (Möglichkeiten, Kosten etc.)? Welchen Einfluss haben soziale Aspekte oder Einstellungen? Wovon hängt es ab, ob eine Technologie als risikoreich eingestuft wird?


Literature


701-0985-00L Social Intercourse with Current Environmental Risks

W 1 credit 1V B. Nowack, C. M. Som-Koller

Abstract

The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

Objective

- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)
- Knowledge about possibilities for sustainable innovation

Content

- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- Prospects for future developments

Lecture notes

Copies of slides and selected documents will be distributed

Prerequisites / notice

The lecture is held biweekly (for 2 hours). The dates are 21.9., 28.9 (attention, out of schedule) ; 19.10, 2.11, 16.11, 30.11, 14.12

227-0802-02L Sociology

W 2 credits 2V A. Diekmann

Abstract

Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected sociological topics. The goal of the course is to provide participants with an understanding of working practice in empirical sociology and the central findings of sociological studies (forest and pasture).

Objective

To learn about methods of empirical social research and key results of classic and modern sociological studies.
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Particularly suitable for students of D-ITET, D-USYS

Prerequisites:
- Schriftliche Arbeit in Soziologie (Durchführung einer kleinen empirischen Studie, Konstruktion eines Simulationsmodells sozialer Prozesse oder Diskussion einer vorliegenden soziologischen Untersuchung).

Literature

- Folien der Vorlesung im Internet
- Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Content


Folgende Themen werden behandelt:


Gruppenarbeiten

- Schriftliche Arbeit in Soziologie (Durchführung einer kleinen empirischen Studie, Konstruktion eines Simulationsmodells sozialer Prozesse oder Diskussion einer vorliegenden soziologischen Untersuchung).

851-0591-00L

Digital Sustainability in the Knowledge Society

Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS

Abstract

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models, e.g. Open Source/Content/Access. The course discusses the consequences from different models and introduces «digital sustainability» as an alternative vision for society.

Objective

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to:
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- explain an example, explaining the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

Content

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in human kind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

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As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from other domains (e.g. scientific knowledge, music)...

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As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from other domains (e.g. scientific knowledge, music)...

851-0594-00L

International Environmental Politics

Particularly suitable for students of D-ITET, D-USYS

Abstract

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.
### Module Individual Sciences

#### Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0721-00L</td>
<td>Psychology</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>R. Hansmann, C. Keller, M. Siegrist</td>
</tr>
</tbody>
</table>

**Abstract**
- This course provides an introduction to psychological research and modelling, focusing on cognitive psychology and the psychological experiment. Participants learn to formulate problems for psychological investigation and apply basic forms of psychological experiment.
- Students are able to describe the areas, concepts, theories, methods and findings of psychology.
- Differentiate scientific psychology from "everyday" psychology.
- Structure the conclusions and significance of an experiment, according to a theory of psychology.
- Formulate a problem for psychological investigation.
- Apply basic forms of psychological experiment.

**Content**
- Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des psychologischen Experiments. Themen sind u.a.: Wahrnehmung; Lernen und Entwicklung; Denken und Problemlösen; Kognitive Sozialpsychologie; Risiko und Entscheidung.

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<tbody>
<tr>
<td>752-2120-00L</td>
<td>Consumer Behaviour I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Keller, B. S. Sütterlin</td>
</tr>
</tbody>
</table>

**Abstract**
- Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior.

**Objective**
- You learn how to handle tools and concepts in environmental communication. And you can evaluate communication projects. We also discuss the evolution of consciousness.
- Methods and tools in environmental communication.
- Marketing mix
- Examples of campaigns, events, print products, media relations.
- Integral sustainability

**Core Courses**

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>701-0771-00L</td>
<td>Environmental Consciousness and Public Relations</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>R. Locher</td>
</tr>
</tbody>
</table>

**Abstract**
- "Environmental Consciousness and Public Relations" shows how to communicate about environment and sustainability successfully. We look at campaigns, exhibitions and other public relations measures to learn, how to design and realize good communication.

**Objective**
- Sign in until 24.09.2015.
- Please describe your expectations. Why do you want to attend this special topic? Do you have any pre-information about the integral model? Do you have any practical experience in environmental communication?
- "Environmental Consciousness and Public Relations" shows how to communicate about environment and sustainability successfully. We look at campaigns, exhibitions and other public relations measures to learn, how to design and realize good communication.
- You learn how to handle tools and concepts in environmental communication. And you can evaluate communication projects. We also discuss the evolution of consciousness.
- Methods and tools in environmental communication.
- Marketing mix
- Examples of campaigns, events, print products, media relations.
- Integral sustainability

**Lecture notes**
- Handouts

**Literature**
- Integral Vision; Ken Wilber, 2005

**Prerequisites / notice**
- We will discuss new trends in environmental communication with the focus on integral solutions.
I. Introduction
- Topics: Environment, Science, Risks, Media
- Forms, Functions, Effects of Public and Mass Communication

II. Stakeholders and their Public Relations Efforts
- Public Relations and Science PR: Theoretical Perspectives, Instruments

III. Science and Environmental Issues in the Media
- Forms and Functions of Science Journalism
- Problems of Selection, Interpretation, Quality
- Media Content Analysis
- Online Communication

IV. Uses and Effects of Science and Environmental Communication
- Extent of Media Use
- Effects on Knowledge, Risk Perceptions, Environmental Attitudes
- Effects on Science itself

Lecture notes
Literature

Prerequisites / notice
Voraussetzungen: Die Vorlesung wendet sich auch an Studierende der Publizistikwissenschaft der Universität Zürich

Module Humanities
Compulsory Courses

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-0701-00L</td>
<td>Philosophy of Science</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>G. Hirsch Hadorn, C. J. Baumberger</td>
</tr>
</tbody>
</table>

Abstract
The lecture explores various strands in philosophy of science in a critical way, focusing on the notion of rationality in science, especially with regards to environmental research. It addresses the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

Objective
Students learn to engage with problems in the philosophy of science and to relate them to natural and environmental sciences, thus developing their skills in critical thinking about science and its use. They know the most important positions in philosophy of science and the objections they face. They can identify, structure and discuss issues raised by the use of science in society.

Content
1. Core differences between classical Greek and modern conceptions of science.
2. Classic positions in the philosophy of science in the 20th century: logical empiricism and critical rationalism (Popper); the analysis of scientific concepts and explanations.
3. Objections to logical empiricism and critical rationalism, and further developments: What is the difference between the natural sciences, the social sciences and the arts and humanities? What is progress in science (Kuhn, Fleck, Feyerabend)? Is scientific knowledge relativistic? What is the role of experiments and computer simulations?
4. Issues raised by the use of science in society: The relation between basic and applied research; inter- and transdisciplinarity; ethics and accountability of science.

Lecture notes
A reader will be available for students.

Literature
A list of introductory literature and handbooks will be distributed to the students.

Prerequisites / notice
Oral examination during the Prüfungssession.

The optional exercises accompany the lecture and offer the opportunity for an in-depth discussion of selected texts from the reader.

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<tr>
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<tbody>
<tr>
<td>701-0703-00L</td>
<td>Environmental Ethics</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Huppenbauer</td>
</tr>
</tbody>
</table>

Abstract
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

Objective
On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies.

Content
- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)
Lecture notes

Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, Zürich 2010 (to be published Autumn 2010).

- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O'Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

General introductions:
- Marcus Düwell et. al (Hrg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice

The procedure for accumulating CP will be explained at the start of term.

I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

Core Courses

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<tbody>
<tr>
<td>701-0701-01L</td>
<td>Philosophy of Science: Exercises</td>
<td>W</td>
<td>1</td>
<td>1U</td>
<td>G. Hirsch Hadorn, C. J. Baumberger</td>
</tr>
</tbody>
</table>

Abstract

The exercises in philosophy of science serve to develop skills in critical thinking by discussing seminal texts about the rationality of science. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

Objective

Students can engage with problems in the philosophy of science and to relate them to natural and environmental sciences. They learn to analyze and summarize philosophical texts. In this way, they develop their skills in critical thinking with a focus on the rationality of science.

Content

The optional exercises accompany the lecture and serve to develop skills in critical thinking with a focus on the rationality of science, based on discussing seminal texts. The texts cover important positions in the philosophy of science and their critics. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

Literature

A list of literature will be distributed to the students together with the reader.

Prerequisites / notice

Students that want to subscribe for this course also have to subscribe for the lecture "Wissenschaftsphilosophie". Credit points are given for preparing a structure and a summary of one of the texts.

Environmental History - Introduction and Overview

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<tbody>
<tr>
<td>701-0791-00L</td>
<td>Environmental History - Introduction and Overview</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>D. Speich Chassé</td>
</tr>
</tbody>
</table>

Abstract

Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

Objective

Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one’s own standpoint.

Literature


Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.


Prerequisites / notice

Students are asked to write an exam during the second last session (11.12.2015).

Compulsory Electives D-GESS (For All Modules Eligible)

- Political Science
- Law
- Sociology
- Economy
- Psychology, Pedagogics
- History
- Philosophy
- Science Research

Natural and Technical Electives

Natural Science Modules

Biomedicine

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<tbody>
<tr>
<td>376-0151-00L</td>
<td>Anatomy I and Physiology I</td>
<td>W</td>
<td>6</td>
<td>4V</td>
<td>M. Ristow, M. Flück, L. Slomianka, C. Spengler, N. Wenderoth, D. P. Wolfer</td>
</tr>
</tbody>
</table>

Abstract

Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, the neuro-muscular system, the cardiovascular system and the respiratory system.

Objective

Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.

Content

- Anatomy and Physiology I (fall term):
  - Basics of cytology, histology, embryology, general pathology; nervous system, muscles, cardiovascular system, respiratory system
  - Anatomy and Physiology II (spring term):
  - digestive system, kidney and urinary tract, endocrine system, skin, thermoregulation, sensory organs, male and female reproductive system, pregnancy and child birth.
This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.

Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

Handouts in lectures.


The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges.

Introduction to Engineering Geology

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media. Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior.

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity.

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing.

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poisuelle's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow.

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion Eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Methods of Statistical Data Analysis

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-0105-00L</td>
<td>Applied Statistics for Environmental Sciences</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>U. Brändle, C. Bigler, M. Kalisch, L. Meier</td>
</tr>
</tbody>
</table>

Statistical methods from current publications in environmental sciences are presented and applied. Students are enabled to understand the methods, clean datasets, analyse them using the software package R and present the results in a suitable form. They will be able to describe strengths and weaknesses of the methods for given fields of application.
The students will be able to use the software R for simple data analysis. Students are able to
- use suitable statistical methods for data analysis in their subject area.
- characterize data sets using explorative methods.
- check the suitability of data sets to answer a given question, prepare data sets for import to a statistics program and conduct the analysis.
- interpret statistical analyses and process them graphically for use in presentations and publications.
- describe the basics of statistical methods used in current publications.
- use the software package R for statistical analysis.

**Objective**
Students should have a good understanding of the concepts of general sampling theory in a modern framework. They should also master
Using R for Data Analysis and Graphics (Part II)
- Extending basic R: packages
- Tayloring R: options
- Object oriented programming with R: classes and methods.

**Content**
Using R for Data Analysis and Graphics (Part II)

**Prerequisites / notice**
Note: This part builds on “Using R... (Part I)”, but can be taken independently if the basics of R are already known.

**Literature**
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

**Objective**
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge
- Introduction to design and model assisted sampling theory for finite populations as well as to the infinite population model for forest
- The course provides the second part of an introduction to the statistical software R for scientists. R is free software that contains a huge

**Content**
Using R for Data Analysis and Graphics (Part I)

**Prerequisites / notice**
Note: This part builds on “Using R... (Part I)”, but can be taken independently if the basics of R are already known.

**Literature**
- A simulation software will be used throughout the lectures to illustrate the theoretical developments. Upon request a half day field
development can be observed at the WSL outside the lecture time. A repetition for the exam is also offered.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

**Objective**
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge
- A. J. Papritz, C. B. Schwierz

**Content**
Using R for Data Analysis and Graphics (Part I)

**Prerequisites / notice**
Note: This part builds on “Using R... (Part I)”, but can be taken independently if the basics of R are already known.

**Literature**
- A. J. Papritz, C. B. Schwierz

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

**Objective**
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge
- C. B. Schwierz

**Content**
Using R for Data Analysis and Graphics (Part I)

**Prerequisites / notice**
Note: This part builds on “Using R... (Part I)”, but can be taken independently if the basics of R are already known.

**Literature**
- C. B. Schwierz

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org
The course deals with a number of main topics that include feeding and resource use, spatial behaviour and migrations, reproduction, and vertebrate ecology. The students are familiar with important topics in animal ecology, with an emphasis on birds and mammals. They are able to link theoretical concepts with visible ecological phenomena, and view them against an evolutionary backdrop. They can thus appraise applied aspects of conservation and the use of animal populations, such as the influence of larger predators on prey populations or of herbivores on vegetation, the effects of hunting, landscape change, or of other human influences on animal populations. They understand the biogeographical characteristics of the Central European vertebrate fauna and its temporal and spatial dynamics.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

### Ecology and Conservation Biology

#### Number Title Type ECTS Hours Lecturers
701-0305-00L Vertebrate Ecology W 2 credits 2G W. Suter, J. Senn

- The course offers an overview on the ecology and conservation biology of birds and mammals. Important concepts from physiology, behavioural ecology, population biology, biogeography and community ecology will be linked to applications in conservation and management. A worldwide perspective will be complemented by a focus on the Central European fauna and its dynamics.
- The students are familiar with important topics in animal ecology, with an emphasis on birds and mammals. They are able to link theoretical concepts with visible ecological phenomena, and view them against an evolutionary backdrop. They can thus appraise applied aspects of the conservation and use of animal populations, such as the influence of larger predators on prey populations or of herbivores on vegetation, the effects of hunting, landscape change, or of other human influences on animal populations. They understand the biogeographical characteristics of the Central European vertebrate fauna and its temporal and spatial dynamics.

- The course deals with a number of main topics that include feeding and resource use, spatial behaviour and migrations, reproduction, population dynamics, competition and predation, biodiversity and distributions, and dynamics of the Central European fauna. There is an emphasis on linking theory with management issues in conservation and management of wildlife populations. During the first half of the course, examples will be drawn worldwide whereas during the second half, the course will focus more strongly on the Central European fauna. Students are expected to read one paper and to present it to the audience. In addition, two optional field trips will be offered on weekends during the semester (2 days in the Swiss National Park: probably 10-11 October, one day in an important wetland for waterbirds: a Saturday in Nov./Dec., by arrangement).
- For the detailed program, see the German text.

- Literature will be listed in the lecture notes, and papers to be presented will be distributed if needed. Some books relevant to the course are (optional reading):
  - Everybody will be expected to present a scientific paper in class, to be chosen from a list given.


- Literature will be listed in the lecture notes, and papers to be presented will be distributed if needed. Some books relevant to the course are (optional reading):
  - Montgomery et al. (2006): Introduction to Linear Regression Analysis
  - Fox (2008): Applied Regression Analysis and GLMs
  - Draper & Smith (1998): Applied Regression Analysis
  - Faraway (2006): Extending the Linear Model with R

- The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

- In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.
Abstract
In this course the important freshwater ecosystems, on a global perspective, will be presented. The foci of the lectures are basic ecological properties of those aquatic systems, their anthropogenic influences and subsequent modifications. The learning is organized along case studies, for which conflicting interests, as well as concepts and methods for sustainable management will be discussed.

Objective
basics concerning the functioning of the most important freshwater ecosystems
basics of the sustainable management of aquatic ecosystems
application of these principles with case studies
critical analyses, organization of discussion groups

Content
1. Globaler Zustand der Binnengewässer und Entwicklungen
2. Globale Wasserkonflikte
3. Stauhaltungen und downstream Effekte
4. Restwasser und Schwalm-Sunk Management, Thermische Verunreinigung
5. Renaturierung von Fließgewässern
6. Interessenskonflikte bei Renaturierung: Trinkwasser, Hochwasserschutz und Biodiversität
7. Feuchtgebiete
8. Management urbaner Gewässer, wasserbürtige Krankheiten
9. Gewässerschutz und gesetzliche Grundlagen
10. Invasion ortsstremender Arten und Biodiversität
11. Europäische Wasserrahmenrichtlinie

Lecture notes
themenspezifische Unterlagen werden verteilt und auf
http://www.wsl.ch/info/mitarbeitende/scheideg/vorlesung_binnengewaesser_DE
zugänglich gemacht.

Literature
Literaturlisten zu den Fallbeispielen werden abgegeben und auf
http://www.wsl.ch/info/mitarbeitende/scheideg/vorlesung_binnengewaesser_DE
zugänglich gemacht.

Prerequisites / notice
Basic ecology lectures of the first four semesters. Students will organize discussion groups.

Environmental Chemistry/Ecotoxicology

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>701-0201-00L</td>
<td>Introduction to Environmental Organic Chemistry</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>M. Sander, E. Janssen, K. McNeill</td>
</tr>
</tbody>
</table>

Abstract
This course presents significant organic environmental pollutants and the physical-chemical bases required to understand their environmental behavior, and deepens this knowledge through exercises. The most important analytical methods for the qualitative and quantitative determination of organic pollutants in environmental samples are discussed.

Objective
The students are able to
- name and recognise the most important classes of environmentally-relevant anthropogenic chemicals.
- explain, on the basis of physical-chemical foundations, the most important processes which determine the environmental behavior of organic pollutants.
- name fundamental methods of trace analysis of organic pollutants in environmental sampling.
- propose experimental methods for determining substance-specific properties.
- identify, on the basis of chemical structure, the processes relevant for the environmental behavior of a compound.
- critically evaluate published work and data.

Content
- Overview of the most important classes of environmental organic pollutants
- Molecular interactions that determine the partitioning behavior (adsorption and absorption processes) of organic compounds between different environmental compartments (gas, liquid, solid)
- Physical-chemical properties (vapor pressure, aqueous solubility, air-water partition constant, organic solvent-water partition constants, etc) and partitioning behavior of organic compounds between environmentally relevant phases (air, aerosols, soil, water, biota)
- Basics of trace analytical methods to determine organic compounds (enrichment techniques, separation (chromatography), detection)
- Chemical transformation reactions of organic pollutants in aquatic and in terrestrial systems (reactions with nucleophiles incl. hydrolysis, elimination, addition)

Lecture notes
Script will be distributed

Literature

Prerequisites / notice
Die Lehrveranstaltung richtet sich nicht nur an jene Studierenden, welche sich später chemisch vertiefen wollen, sondern ausdrücklich auch an alle jene, welche sich mit der Problematik von organischen Schadstoffen in der Umwelt vertraut machen wollen, um dieses Wissen in anderen Vertiefungen anzuwenden

701-0225-00L Organic Chemistry W 2 credits 2V K. McNeill

Abstract
Introduction to Isomerism.
Reaction mechanisms in organic chemistry (substitutions, additions, eliminations condensations)
Biosynthesis of Terpenes.

Objective
The students are able to differentiate between structural and stereoisomers.
The students know the basic reaction mechanisms in organic chemistry. They are able to understand and formulate simple biochemical reactions.
They know the basics of the biosynthesis of terpenes.

Content
Isomerism (structural isomers, stereoisomers).
Descriptive chemistry of natural products (glycerides, peptides, saccharides).
Reaction mechanisms (substitutions, additions, eliminations, condensations).
The citric acid cycle, the gloxylate cycle.
Biosynthesis of terpenes.

Literature
Carsten Schmuck, Basisbuch Organische Chemie, Pearson

Prerequisites / notice
Der Stoff der Basischemie wird vorausgesetzt.

701-0297-00L Applied Ecotoxicology W 2 credits 2V K. Fent

Abstract
Besides regarding basic concepts, this lecture focus on applied aspects of ecotoxicology. Case studies and effects of environmental chemicals on cells, organisms up to ecosystems are regarded. In a multidisciplinary approach based on toxicological concepts, pollutants are analysed, in particular hormonally active compounds and their effects on reproduction.
Objective
This lecture focusses on basic concepts of ecotoxicology and their application to environmental chemicals and environmental pollution problems. Basic concepts are regarded with respect to their consequences for the environment. Toxicological effects on organisms are analysed at different levels of organisation, from the molecular to the ecosystem level. Case studies are regarded in order to understand chemical's actions and their effects. In addition bioaccumulation and their consequences, the methods in ecotoxicology and environmental effects of various compounds will be regarded. Emphasis will be placed on hormonally active compounds and their effects to aquatic organisms. Furthermore, methods of environmental risk assessment of environmental pollutants will be discussed.

Content

Lecture notes

Literature

Environmental Fluid Dynamics

<table>
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<tr>
<th>Type</th>
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<tr>
<td>2G</td>
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<td>3G</td>
<td>3</td>
<td></td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
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<tr>
<td>W</td>
<td>3</td>
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Abstract
Introduction into the most important spectroscopical methods and their applications to gain structural information.

Content
- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
- UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) and optical rotation dispersion (ORD).

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites
Script will be for the production price

Notice
Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.
Content

Introduction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.

Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.

Flow equations, stream function.

Exercises: Darcy’s law.

Analytical solutions, confined aquifers, steady-state flow.

Exercises: Head isolines.

Use of superposition principles, transient flow, freee surface flow.

Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.

Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.

Exercises: Finite difference formulations to flow problems.

Transport processes.

Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.

Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.

Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.

Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.

Exercises: Groundwater remediation.

Lecture notes

Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index

Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index

Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index

Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature


W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995

Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970

G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

651-3561-00L

Cryosphere W 3 credits 2V M. Funk, M. Huss, K. Steffen

Abstract

This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

Objective

Students are able
- to qualitatively describe the main components of the cryosphere and their role in the climate system
- to formally describe the relevant physical processes which determine the state of cryosphere components

Content

Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system.

Each part is used to emphasize on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.

Lecture notes

handouts will be distributed during the teaching semester

Module Engineering and Planning

Spacial and Transport Planning

Number

Title

Type

ECTS

Hours

Lecturers

701-0951-00L

GIS - Introduction into Geoinformation Science and Technology W 5 credits 2V+3P M. A. M. Niederhuber, S. Salvini

Number of participants limited to 80.

Abstract

Theoretical basics and fundamental concepts of Geographic Information Science (GIS) are imparted and subsequently further elaborated with the software ArcGIS.

At the end, the students will be able to independently solve basic realistic GIS problems.

Objective

Students are able to
- elucidate the theoretical and conceptional foundations of geographic information systems (GIS)
- independently perform normal GIS work using commercial software and practical examples
The course covers the following topics:
- What is GIS? What are spatial data?
- The representation of reality by means of spatial data models; vector, raster, TiN
- The four phases of data modelling: Spatial, conceptual, logical and physical model
- Basic concepts of database management systems and spatial databases
- Possibilities of data collection
- Transition of reference frame
- Spatial Analysis I: query and manipulation of vector data
- Spatial Analysis II: operators and functions with raster data
- Digital elevation models and derived products
- Process modelling with vector and raster data
- Presentation possibilities of spatial data

One Friday is reserved for a field trip or guest speaker;


Prerequisites / notice
Aufgrund der Grösse des verfügbaren EDV-Schulungsräumes ist die Teilnehmerzahl auf 80 Studierende beschränkt! Für die Übungen werden die Studierenden auf verschiedene Zeitenfenster aufgeteilt. Pro Zeitenfenster können maximal 20 Studierende betreut werden.

101-0415-01L  Railway Infrastructures (Transportation II)  W  3 credits  2G  U. A. Weidmann

Fundamentals of railroad technology and interactions between track and vehicles, network development and infrastructure planning, planning of rail infrastructure, planning and design of railway stations, construction and dimensioning of tracks, approval and beginning service on complex infrastructure facilities, special issues of maintenance

Teaches the basics principles of public transport network and topology design, geometrical design, dimensioning and construction as well as the maintenance of rail infrastructures. Teaches students to recognize the interactions between the infrastructure design and the production processes. Provides the background for Masters degree study.

Lecture notes
Course notes will be provided in German. Slides are made available some days before each lecture.

Number  Title  Type  ECTS  Hours  Lecturers
701-0967-00L  Project Development in Renewable Energies  W  2 credits  2G  R. Rechsteiner, A. Appenzeller, A. Wanner

Project development in renewable Energies
Realization of projects in the field of renewable energies, analysis of frame conditions and risks. The students learn basics of renewable energy project realization from acknowledged experts active in the field. They identify the different tasks of various investor types. They develop sample projects in practice within groups

You become acquainted with the regulative, juridical and economic requirements of project development in renewable energies.
You learn to launch and judge projects by exercises in groups
You recognize chances and risks of renewable energy projects

Business models for renewable energy projects
Introduction of market trends, market structure, technical trends and regulation in Switzerland and in the EU internal energy market
Necessary frame conditions for profitable projects
Project development samples and exercises in wind power, hydro power, photovoltaics
due diligence and country assessment.
Exact Program in German below
http://www.rechsteiner-basel.ch/index.php?id=27

PPT presentation will be distributed (in German) special frames:
http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html

REN21 Renewables GLOBAL STATUS REPORT http://www.ren21.net
Mit einer grünen Anlage schwarze Zahlen schreiben http://www.rechsteiner-basel.ch/uploads/media/Mit_einer_gruenen_Anlage_schwarze_Zahlen_schreiben.pdf
http://emp.lbl.gov/sites/all/files/lbnl-6356e.pdf

For group exercise and presentation reasons the number of participants is limited at 30 students. For exercises students build learning and presentational groups.

The lecture series Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity), wind and ocean energy, heat pumps, geothermal energy, solar, O2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed during the course.

Literature

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

### Individual Subjects

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>701-0317-00L</td>
<td>Identification of Woody Plants in Winter</td>
<td>W</td>
<td>1</td>
<td>1G</td>
<td>A. Rudow</td>
</tr>
</tbody>
</table>

Abstract
Woody plants are important elements of forest ecosystems and landscapes. The practical characterization of forest stands often requires the practical identification of woody plants in winter. The course focuses on the practical identification of native tree and shrub species to be used for the characterization of forest stands.

Objective
Knowledge of selected native tree and shrub species in winter. Understanding relationships of trees and forest ecosystems by in situ observation of woody plants and forest stands. Introduction into the characterization of forest stands.

Content
Four half-day excursions in the surroundings of Zurich and Baden. The identification of native tree and shrub species is treated. The course aims at broadening and application of species knowledge towards the identification of woody plants during the leafless phase and their identification from distance (selected native species). By the application in characterization of forest stands the relationships of trees and forest ecosystems as well as forestry aspects are elucidated. In the context of an individual work the students will practically train and deepen their acquired knowledge.

Lecture notes
Rudow, A., 2013: Dendrologie Grundlagen - Bestimmungshilfe (in German, will be provided for registered students on an online-platform)

Literature
Rudow 2011 (betaversion): eBot Dendrologie. E-learning-Tool for the support of dendrology courses at ETHZ, integrated into online-application eBot.

An overview of the most adequate literature will be given at the introduction (sept 23).

Prerequisites / notice
Half-day excursions into forests. Weatherproof clothes are presupposed.

The course is based on the Introduction into Dendrology (2nd sem).

| 051-0159-00L | Urban Design I                  | W    | 1    | 2V    | H. Klumpner. A. Brillemburg |

Abstract
The lecture series will introduce tools for reading contemporary urban conditions, urban models and operational modes. Urban development will be deciphered, presented as operational tools, extracted from cities where they have been tested and became exemplary samples, most relevant for providing the understanding of how urban landscape has taken shape as well as inspiration for future practice.

Objective
How can a glossary of tools be used as a basis for reading cities and recognizing in them current trends and urban phenomena? The lectures series produce a glossary of operational urban tools with collected urban knowledge that provides students with an 'improved' manual to navigate theories. Urban Stories is a lecture series that aims to amplify your repertoire of urban instruments and empowers you to read cities and to critically reflect on the urban environment. The course will approach a series of case studies, employing an analytical, research-based model for crosscutting scale, political, economical and social components. Through this lens, and with our toolbox, we aim to tell the fundamental story of our cities from today and provide information, analysis and knowledge to help students prepare for justifiable own contributions and interventions in the future. Also the aspect of knowledge transfer will be considered in order to sensibilize the students to understand how to operate in an international context.

Content
How did cities develop into the cities we live in now? Which urban plans, instruments, visions, political decisions, economic reasonings, cultural inputs and social organization have been used to operate in urban settlements in specific moments of change? Which cities are exemplary in illustrating how these instruments have been implemented and how they have shaped urban environments? Can these instruments be transcribed into urban operational tools that we recognize within existing tested cases in contemporary cities across the globe? How can form become reduced to the physical space. Cities are the result of social construction, under the influence of technologies, ecology, culture, the impact of experts and accidents. Urban uncontrolled processes respond to political interests, economic pressure, cultural inclinations, along with the imagination of architects and planners and the informal powers at work in complex adaptive systems. Current urban phenomena are the result of an urban evolution. The facts stored in urban environments include contributions from its entire lifecycle. This is true for the physical environment, but also for non-physical aspects, the imaginary city that exists along with its potentials and problems and with the conflicts that have evolved over time. Knowledge and understanding along with a critical observation of the actions and policies are necessary to understand the diversity and instability present in the contemporary city and to understand how urban form evolved to its current state. This lecture series will introduce urban knowledge and the way it has introduced urban models and operational modes within different concrete realities, therefore shaping cities. Urban knowledge will be translated into operational tools, extracted from cities where they have been tested and become exemplary samples, most relevant for providing the understanding of how urban landscape has taken shape. Case studies will be identified to compile documents and an archive, that we use as templates to read the city and to critically reflect upon it. The presented contents are meant to serve as inspiration for positioning in future professional life as well as to provide instruments for valuable contributions and interventions.

Lecture notes
The script can be downloaded from the student-server.

Literature
The learning material can be downloaded from the student-server: aftp://brillembourg-klumpner-server.ethz.ch

Please check also the Chair website: http://u-terrach.ethz.ch

Courses of the Specialisation in an Environmental System

### Biogeochemistry

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<tr>
<td>701-0216-00L</td>
<td>Biogeochemical Cycles</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>B. Wehrli</td>
</tr>
</tbody>
</table>

**Abstract**

Biogeochemical cycles in aquatic systems are discussed from a global or regional perspective. Important methods to determine reaction rates and pathways are introduced and typical mechanisms are discussed on a molecular level.

**Objective**

The course aims at

* connecting global and molecular ideas;
* informing the students how to determine rates and pathways of biogeochemical cycles;
* providing insights on coupling mechanisms between biological and geochemical processes.

**Content**

Biogeochemical cycles in aquatic systems will be discussed from three perspectives: 1) Case studies with a global or regional point of view will document the relevant background information on rates, time-scales and reservoirs of selected element cycles such as C, N, P, S, Fe, Mn, Cd, Cu, Mo and As. 2) From a practical perspective we will compare the potential and limits of different methods to quantify biogeochemical processes in aquatic systems. 3) On a molecular level we will discuss mechanisms and pathways of relevant reactions.

**Prerequisites / notice**

Basic knowledge in chemistry and systems analysis

1. **Seminar for Bachelor Students: Biogeochemistry**
   - **Number**: 701-0419-01L
   - **Title**: Seminar for Bachelor Students: Biogeochemistry
   - **Type**: O
   - **ECTS**: 2 credits
   - **Hours**: 2S
   - **Lecturers**: G. Furrer, R. Kretzschmar, B. Wehrli

   **Abstract**

   The seminar provides an introduction to the literature in biogeochemistry of aquatic and terrestrial systems. The students present their summary and review of recent or classical papers. Therefore they get familiar with online-access tools and improve their communication and presentation skills.

   **Objective**

   Getting to know relevant journals in the field of biogeochemistry. Reading, assessing and discussing scientific publications. Improving of presentation skills. Exercising and Improving of moderation skills.

   **Content**

   Part 2: Common literature study; online-exchange of information. Presentation and discussion moderated by the students.

   **Lecture notes**

   Lecture notes and assignments will be available in German

   **Prerequisites / notice**

   Deadline for enrollment is the FIRST day of the semester. Later enrollment can only be accepted in exceptional cases and under certain conditions (e.g., restricted choice of topics and dates).

2. **Chemistry of Aquatic Systems**
   - **Number**: 701-0423-00L
   - **Title**: Chemistry of Aquatic Systems
   - **Type**: W
   - **ECTS**: 3 credits
   - **Hours**: 2G
   - **Lecturers**: L. Winkel

   **Abstract**

   This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

   **Objective**

   Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters. Evaluation of analytical data from aquatic systems.

   **Content**

   Introduction to the chemistry of aquatic systems. Regulation of the composition of natural waters by chemical, geochemical and biological processes. Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.

   **Prerequisites / notice**

   Script is distributed.

3. **Soil Chemistry**
   - **Number**: 701-0533-00L
   - **Title**: Soil Chemistry
   - **Type**: W
   - **ECTS**: 3 credits
   - **Hours**: 2G
   - **Lecturers**: R. Kretzschmar, D. I. Christl

   **Abstract**

   This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

   **Objective**

   Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.

   **Content**

   Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

   **Prerequisites / notice**

   Lectures in lectures.

4. **Environmental Soil Physics/Vadose Zone Hydrology**
   - **Number**: 701-0535-00L
   - **Title**: Environmental Soil Physics/Vadose Zone Hydrology
   - **Type**: W
   - **ECTS**: 3 credits
   - **Hours**: 2G+2U
   - **Lecturers**: D. Or

   **Abstract**

   This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

   **Objective**

   Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, mobility) of nutrients and pollutants.

   **Content**

   Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

   **Prerequisites / notice**

   Lectures in lectures.
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/ near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

**Objective**

Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

**Content**

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media Units and dimensions, definitions and basic mass-volume relationships

**Lecture notes**

**Literature**

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange, and challenges for bio- and phytoremediation.

Classnotes on website: VadoseZoneHydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)

**Atmosphere and Climate**

**Number** 701-0459-00L 701-0461-00L

**Title** Seminar for Bachelor Students: Atmosphere and Climate Numerical Methods in Environmental Sciences

**Type** W W

**ECTS** 2 3

**Hours** 2S 2G

**Lecturers** R. Knutti, E. M. Fischer, O. Stebler C. Schär, O. Fuhrer

**Abstract** In this seminar all students in the realm of atmospheric and climate science convene to train presentation techniques (talks, posters) by means of classic and modern scientific articles.

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**Content**

1st week: course organisation and presentation of the institute
2nd and 3rd week: introduction to oral presentation technique week 4 to 10: students talks
11th week: introduction to poster presentation technique
12th and 13th week: poster design
14th week: concluding poster presentation

Documents are offered via the course's web page.

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This course can only be offered to a limited number of students, however, in any case for everybody having to attend it compulsory. We beg you to sign in to this course early.

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**Lecture notes**

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**Literature**

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

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**Literature**

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Objective

This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Content

Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Lecture notes

Is provided (CHF 10. per copy).

Prerequisites / notice

Die Vorlesung verlangt Vorkenntnisse in Linearer Algebra, Analysis und Physik (z.B. komplexe Zahlen, Beschreibung von ebenen Wellen, einfache gewöhnliche Differentialgleichungen)

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<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>701-0471-01L</td>
<td>Atmospheric Chemistry</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Ammann, D. W. Brunner</td>
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<tr>
<td>701-0473-00L</td>
<td>Weather Systems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. A. Sprenger, C. Grams</td>
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<tr>
<td>701-0475-00L</td>
<td>Atmospheric Physics</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>U. Lohmann, A. A. Mensah</td>
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Environmental Biology

Number | Title |
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<tr>
<td>701-0301-00L</td>
<td>Ecosystem Ecology (Advanced Course)</td>
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This course provides the ecological systems' knowledge needed to question applied solutions to current environmental issues. Our central aim is to balance participants' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.
Objective
At the end of the course...

...you know how to structure your inquiry and how to proceed the analysis when faced with a complex environmental issue. You can formulate the relevant questions, find answers (supported by discussions, input from the lecturers and the literature), and you are able to present your conclusions clearly and cautiously.

...you understand the complexity of interactions and structures in ecosystems. You know how ecosystem processes, functions and services interact and feedback across multiple spatio-temporal scales (in general, plus in depth case examples).

...you understand that biodiversity and the interaction between organisms are an integral part of ecosystems. You are aware that the link between biodiversity and process/function/service is rarely fully understood. You know how to honestly deal with this lack of understanding and can nevertheless find, critically analyse and communicate solutions.

...you understand the importance of ecosystem services for society.

...you have an overview of the methods of ecosystem research and have a deeper insight into some of them, e.g. ecosystem observation, manipulation and modelling.

...you have reflected on ecology as a young discipline at the heart of significant applied questions.

Content
This course provides the ecological systems' knowledge needed to question applied sustainability solutions. We will critically assess the complexity of current environmental issues, illustrating basic ecological concepts and principles. Our central aim is to balance participants' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.

The course is structured around four larger topical areas: (1) Integrated Water Management -- Green infrastructure (land management options) as an alternative to engineered solutions (e.g. large reservoirs) in flood and drought management; (2) Fire dynamics, the water cycle and biodiversity -- The surprising dynamics of species life cycles and populations in arid landscapes; (3) Rewilding, e.g. re-introducing apex predators (e.g. wolves), or large ungulates (e.g. bisons) in protected areas -- A nature conservation trend with counterintuitive effects; (4) Coupling of aquatic and terrestrial systems: carbon, nitrogen and phosphorus transfers of global importance on landscape scale.

Lecture notes
We would be happy to collaborate with interested participants to produce an (online)script of this course on the basis of our materials (this is a new course that runs for the first time). We will discuss this during the first lecture.

Prerequisites / notice
The course combines elements of a classic lecture, group discussions and problem based learning. It is helpful, but not essential to be familiar with the "seven stages" method (see e.g. course 701-0352-00L "Analysis and Assessment of Environmental Sustainability" by Christian Pohl et al.).

701-0320-00L Seminar for Bachelor Students: Environmental Biology O 2 credits 2S 2 credits D. Rameiser

Abstract
In the seminar, students explore a specific topic in environmental biology (ecology, evolution, health). They find and read scientific articles, structure contents around core questions, talk to specialists about them, prepare a scientific presentation and lead a discussion. They are introduced to literature search and scientific presentations.

Objective
Students will acquire skills in:
- finding literature in scientific databases
- structuring a scientific topic through research questions
- giving a clear scientific presentation
- contributing constructively to a scientific discussion

Content
Week 1: Choice of topics and tutors
Week 3: Literature search
Week 5: Course for presentation techniques
Weeks 1 - 7: Meetings with tutors, preparation of presentations
Weeks 8 - 14: Presentations and discussions

Lecture notes
Will be handed out during classes

701-0323-00L Plant Ecology W 3 credits 2V S. Güsewell, J. Levine

Abstract
This class focuses on ecological processes involved with plant life, mechanisms of plant adaptation, plant-animal and plant-soil interactions, plant strategies and implications for the structure and function of plant communities. The discussion of original research examples familiarises students with research questions and methods; they learn to evaluate results and interpretations.

Objective
Students will be able to:
- propose methods to study ecological processes involved with plant life, and how these processes depend on internal and external factors;
- analyse benefits and costs of plant adaptations;
- explain plant strategies with relevant traits and trade-offs;
- explain and predict the assembly of plant communities;
- explain implications of plant strategies for animals, microbes and ecosystem functions;
- evaluate studies in plant ecology regarding research questions, assumptions, methods, as well as the reliability and relevance of results.

Content
Plants represent the matrix of natural communities. The structure and dynamics of plant populations drives the function of ecosystems. This course presents essential processes and plant traits involved with plant life. We focus on research questions that have been of special interest to plant ecologists as well as current topical questions. We use original research examples to discuss how ecological questions are studied and how results are interpreted.

- Growth: what determines the production of a plant?
- Nutrients: consumption or recycling; opposite strategies and feedbacks on soils;
- Clonality: collaboration and division of labour in plants;
- Plasticity: benefits and costs of plant intelligence;
- Flowering and pollination: how expensive is sex?
- Seed types, dispersal, seed banks and germination: strategies and trade-offs in the persistence of plant populations;
- Development and structure of plant populations;
- Stress, disturbance and competition as drivers of different plant strategies;
- Herbivory: plant-animal feedbacks and functioning of grazing ecosystems
- Fire: impacts on plants, vegetation and ecosystems.
- Plant functional types and rules in the assembly of plant communities.

Lecture notes
Handouts and further reading will be available electronically at the beginning of the semester.
Prerequisites

Lectures and handouts are normally in German, but we shall switch to English on request. Non German-speaking students who intend to attend the course should contact S. Güsewell before the start of the semester to ask for the change in language.

Prerequisites
- General knowledge of plant functioning (Biologie I+II)
- General ecological concepts (Biologie III)
- Overview of plant taxonomy and vegetation types (Biologie IV)

701-1413-00L Population and Quantitative Genetics

Abstract
This course is an introduction to the rapidly developing fields of population and quantitative genetics, emphasizing the major concepts and ideas over mathematical formalism. An overview is given of how mutation, genetic drift, gene flow, mating systems, and selection affect the genetic structure of populations. Evolutionary processes affecting quantitative and Mendelian characters are discussed.

Objective
Students are able to
- describe types and sources of genetic variation.
- describe fundamental concepts and methods of quantitative genetics.
- use basic mathematical formalism to describe major population genetic concepts.
- discuss the main topics and developments in population and quantitative genetics.
- model population genetic processes using specific computer programs.

Content
Population Genetics:
Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.

Quantitative Genetics:
Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher's fundamental theorem.

Lecture notes
Handouts

Literature

Prerequisites / notice
There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

701-1413-01L Ecological Genetics

Abstract
This course provides an introduction to the concepts and methods used in ecological genetics. Topics covered include genetic diversity, adaptation, reproductive isolation, hybridization and speciation.

Objective
To understand how knowledge from individual disciplines can be combined to understand how organisms interact with each other and their environment.

Content
Concepts and methods for the study of genetic diversity, adaptation, reproductive isolation, hybridization and speciation.

Lecture notes
Handouts will be distributed in the lectures.

701-1415-00L Population Biology

Abstract
This course provides an understanding of the basic concepts of population biology. It presents models regarding the dynamics and evolution of populations, and experimental designs for investigating population biology hypotheses (e.g., population growth, species interactions, epidemiology, metapopulations, life history evolution, local adaptation, evolution of sex, and coevolution).

Objective
Students are able
- to describe and apply population biology models (e.g. growth, species interactions)
- to describe and apply epidemiological models
- to substantiate evolutionary concepts (e.g., life history evolution, coevolution, evolution of sex) using population biology arguments and provide examples
- to propose population biology experiments

Content
Population growth, population regulation, predator-prey interactions, host-pathogen interactions, competition, metapopulations, life history evolution, local adaptation, mating systems, sexual selection, coevolution.

Lecture notes
Handouts of lectures

Literature
Recommended:

Human-Environment Systems

Coevolution between Society and Environment: Analysis and Influence

Abstract
Analysis of central mechanisms of the anthroposphere: ecological economics, theory of institutions and innovation, development economics.

Objective
Introduction to the theoretical foundations of the analysis of central mechanisms of the anthroposphere in a sustainable development perspective.

Knowledge of the different scientific and political discussions on sustainable development.

Knowledge of selected analytical tools (Ecological Economics, economic analysis of institutions, innovation theory, Ordnungstheorie, Theory of liberal economic policy).

Ability to identify central non sustainable mechanisms and policies, to formulate adequate research questions, to choose and to use adequate analytical tools, and to elaborate solutions.
The course "Modelling of Human-Environment Systems" provides the basic foundations for the analysis and steering of anthropogenic resource, energy and material flows based on "Systemanalyse". Students are able to
- name the most important resource, energy and material flows and utilize mathematical models for their quantitative description.
- systematically analyse resource problems in the anthroposphere on various levels (company, region, nation).
- observe human-environment systems from the stakeholder perspective.
- analyse, as an example, the interaction of nutrition and climate change as a human-environment system.
- describe approaches for modelling (collective) human behavior and concepts and methods for integrating scientific and social-scientific models.
- systemically analyse resource problems in the anthroposphere on various levels (company, region, nation).

Further reading and citations are listed in the skript and mentioned in the course. Willingness to prepare intensively the topics and to participate actively in the course.

Lecture notes
A first selection:
- Ralf Dahrendorf (2003): Auf der Suche nach einer neuen Ordnung, München
- Ralf Fücks (2013): Intelligent wachsen, Die grüne Revolution, München
- Friedrich A. von Hayek (1972): Theorie komplexer Phänomene, Tübingen
- Jeremy Rifkin (2014): The Zero Marginal Cost Society: The Internet of things, the Collaborative Commons, and the Eclipse of Capitalism, palgrave macmillan
- Uwe Schneidewind / Angelika Zahrnt (2013): Damit gutes Leben einfacher wird. Perspektiven einer Suffizienzpolitik, München

Prerequisites
Sustainable development-update: origins, conceptions, state of the discussion. What's left after 25 years of discussion?

On the way to the second "Great Transformation"

New Trends in the Growth Debate;
- Shifting the air (Hans Chr. Binswanger), Prosperity without growth? (T. Jackson), Intelligent Growth (R. Fücks)
- The Internet of Things and Collaborative Commons - on the road to "The Zero Marginal Cost Society"
- Sufficiency: Perspectives of a resource-light society
- Corporation 2020 - Transforming Business for Tomorrow's World (Remarks on Pavan Sukhdev's bestseller)
- Finance Crash and Debt Crisis - new challenges for Democracy & Market Economy
- Globalization: Facts and elements of a fair globalization

It's the software! Institutional Innovations for Sustainable Development. Let's continue writing The Federalist Papers!

Lecture notes
- A first selection:
  - Ralf Dahrendorf (2003): Auf der Suche nach einer neuen Ordnung, München
  - Ralf Fücks (2013): Intelligent wachsen, Die grüne Revolution, München
  - Friedrich A. von Hayek (1972): Theorie komplexer Phänomene, Tübingen
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Further reading and citations are listed in the skript and mentioned in the course. Willingness to prepare intensively the topics and to participate actively in the course.

701-0655-00L  Modeling Human-Environment Systems Using the Example of Resource Management

Abstract
The course "Modelling of Human-Environment Systems" provides the basic foundations for the analysis and steering of anthropogenic resource, energy and material flows. This involves (i) systemic analysis of resource problems; (ii) mathematical modelling; and (iii) concepts for the integration of scientific and social-scientific models to steer human-environment systems.

Objective
Students are able to
- name the most important resource, energy and material flows and utilize mathematical models for their quantitative description.
- systematically analyse resource problems in the anthroposphere on various levels (company, region, nation);
- observe human-environment systems from the stakeholder perspective.
- analyse, as an example, the interaction of nutrition and climate change as a human-environment system.
- describe approaches for modelling (collective) human behavior and concepts and methods for integrating scientific and social-scientific models.

Content
The structure of the course is as follows:
- Quantification of anthropogenic resource, energy and material flows
- Mathematical modeling of anthropogenic resource, energy and material flows based on "Systemanalyse"
- Introduction into concepts for integrating material flow models with approaches from social sciences
- Approaches for decision modeling

Lecture notes
Will be delivered by the lecturers

Literature

701-0659-00L  Tropical Forests, Agroforestry and Complex Socio-
Environmental Systems

Abstract

The course will focus on integrated landscape approaches for the management of tropical forest landscapes, by addressing the complex interactions between ecological processes, stakeholders' strategies and public policies. Dedicated tools such as games and simulation models to improve knowledge and foster collective decision-making processes will be explored.

Objective

Through the course the students will learn:

Section 1: Concepts and Methods
1. To master definitions and concepts: SES; Vulnerability; Resilience, Environmentalist Paradox.
2. To gain exposure to methods for assessing stakeholders perceptions/practices/knowledge.

Section 2: Recognising diversity & Interdisciplinarity
1. To understand points of views/normative views and how these shape management objectives and practices.
3. To explore interdisciplinary approaches to natural resources management.

Section 3: Topics and Arenas
1. To understand links between Forest, Trees and Livelihoods - poverty, food security & well-being.
2. Gain familiarity with drivers of deforestation; degradation; reforestation.
3. Knowledge of global arenas affecting the international forest regime, and their impact at the local level.
4. To recognise and understand trade-offs between conservation and development in a forest/agroforest context;

A major objective of the course is to encourage students to develop a critical analysis of existing conservation and development narratives within the frame of agroforestry and forested agricultural landscapes. The course will also provide students with methods and tools to assess stakeholders perceptions/practices and knowledge, that will be of use in their professional life.

Content

The course will address:

1- Definitions of forests and agroforests, deconstructing the rigid historical divisions between these two, and showing the complexities and implications legal definitions will have on the management systems. We will also address the definitions of Social and Ecological System (SES) and Resilience, useful for the entire course. We will provide insights on how to describe the SES using the ARDI methodology (Actors, Resources, Dynamics and Interactions)
2- Methodological frameworks to understand drivers and coping strategies of stakeholders (Sustainable livelihood framework & Vulnerability; Ecosystem Services & trade-offs; Companion Modelling and Adaptive Management; Surveys and Participatory Appraisals)

Building upon this, and introducing the Forest Transition curve as guiding framework for the course, a series of case studies will be presented, highlighting the different drivers and issues at each stage of the transition curve (Kanninen et al. 2007).

1- Tropical Forestry - including Reduced Impact Logging, Forest Certification, and International Timber Market.
2- Secondary forests and Agroforests - landscape mosaics, forest fragments, non timber forest products, slash and burn systems, small holder production systems.
3- Conversions and Deforestation: Global trends, Biofuel extensions .
4- Reforestation and Agroforestry : Plantations.
5- Conclusion - Future trends; Global Arenas and Local Governance.

The course will tackle new and emerging topics such as the role of forests and trees in adaptation to climate change, the links between forest, poverty and food security, and the need to mainstream conservation of biodiversity outside protected areas. The course will draw from diverse disciplines, from ecology, economy, sociology, political sciences and legal studies as the most preeminent ones.

The course will enlarge the scope of the students from the ecological process to the social and political components of tropical social and ecological systems. It will address topics and case studies that the students will have little opportunity to address elsewhere, linking them to issues of global relevance in environmental sciences.

Literature


Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.


Prerequisites / notice

Students are asked to write an exam during the second last session (11.12.2015).

701-0791-00L Environmental History - Introduction and Overview W 2 credits 2V D. Speich Chassé

Number of participants limited to 100.

Abstract

Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

Objective

Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems.

Lecture notes

Course material is provided on OLAT.

Literature


701-0963-00L Energy and Mobility W 3 credits 2G P. J. de Haan van der Weg, M. Müller

Abstract

The lecture Energy and Transportation imparts profound knowledge of energy- and environment-related difficulties of the intersection of energy and transportation with focus on the motorized individual traffic. The students gain the ability to approach energy- and environment-related problems with special consideration of the demand side, and to evaluate possible solutions.

Prerequisites / notice

Energy and Mobility
Objective

The main objectives of this lecture are:

(i) The students gain profound knowledge of energy- and environment-related difficulties of the intersection of energy and transportation, and learn strategies to cope with these difficulties.

(ii) The students are able to approach energy- and environment-related problems with special consideration of the demand side, and to evaluate possible solutions.

Content

The lecture Energy and Transportation deals with the intersection of energy and transportation with focus on the motorized individual traffic.

Main topics are:

(i) Fundamentals of energy use in the transportation sector, today's present state and future developments.

(ii) Technical potentials for the reduction of greenhouse gas (GHG) emissions and the dependence on fossil fuels: Evaluation of (a) alternative fuels, and (b) alternative propulsion systems.

(iii) The relevance of demand on efforts to reduce GHG emissions and the dependence on fossil fuels.

(iv) Strategies and measures for influencing the demand side.

Forest and Landscape

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
701-0553-00L | Landscape Ecology | W | 3 credits | 2G | F. Kienast, L. Pellissier

Abstract

This course offers an introduction to landscape ecology and an insight into its various practical applications in nature and landscape management. The course identifies the products which can provide sustainable landscape management (e.g. landscape parks, visually attractive landscapes, renaturalised spaces for species protection, revitalised rivers).

Objective

Students are able to

- explain and apply the concepts and methods of landscape analysis using examples.
- explain the causes and effects of altering the landscape using examples and simulations.
- describe the practical applications of landscape ecology in nature and landscape management.
- explain sustainable landscape management using various examples.

Content

A. Theoretical aspects

- Introduction to Landscape Ecology as a discipline
- Methodological tools of Landscape Ecology
- Landscape analysis I: Qualitative landscape description; landscape patterns and ecological significance for fauna and flora
- Landscape analysis II: Spatial patterns, landscape metrics with practical examples
- Landscape analysis III: Human landscape perception and habitat requirements. Human landscape perception: measuring the human landscape; simulation of disturbances on ecological communities
- Landscape change I: The role of landscape change for plants animals and humans; measuring landscape change; simulation on the role of landscapes

B. Applied landscape ecology in nature and landscape management and corresponding products

- Simulating spatial distribution of selected plant and animal species. Applying distribution models in nature and landscape management, dealing with risks and scenarios.
- Modern river management: flood protection and river restoration (guest lecture)
- Landscape and habitat inventories: Traditional methods, types of inventories, problems of up-dating, new methods of analyzing landscape potentials, new methods for landscape indicators
- Large conservation areas GIS assisted search strategies with landscape ecological data

Lecture notes

Lecture notes will be delivered (in English and partially in German)

Literature

Master students seeking recognition of this course in the Bologna process have to show adequate knowledge of the landscape ecology topics described above and have to read selected chapters of


Introduction, chapter 2, 3, 4, 5, 7, 10

Prerequisites / notice

Lecture with some exercises. For this course and the part landscape ecology in the Systempraktikum Forest and Landscape (summer semester) it is highly recommended to acquire basic skills in Geographic Information Systems (GIS)

701-0559-00L | Seminar for Bachelor Students: Forest and Landscape | O | 2 credits | 2S | O. Holdenheder, C. Bigler, E. Lieberherr, P. Rotach

Abstract

Interdisciplinary seminar on forest and landscape issues with particular emphasis on the key processes shaping the development of forest ecosystems and landscapes.

Objective

- To analyze scientific original articles and other complex materials critically and to present the results in an understandable way.
- To understand selected processes, cases and methods related to forest and landscape issues.
- To be able to analyze problems related to forest ecosystems and landscape from the viewpoint of various disciplines.

Content

Biological, ecological, physical and technical processes with impacts on the community, ecosystem and landscape scale. Social processes and institutions with relation to land use. Products and services of forest ecosystems and landscapes. Forest management systems. The contributions can be organized around topical clusters.

Lecture notes

No script available. The seminar papers will be made available to all participants in electronic form.

Literature

Literature references will be provided by the lecturers.

Prerequisites / notice

The credits are given if the following requirements are met

a) oral presentation (15-20 Min + discussion)

b) seminar paper (up to approx. 5 pages, with references, no powerpoint printout). The contributions can be presented in German or English. We expect a regular and active participation.

701-0561-00L | Forest Ecology | W | 3 credits | 2V | C. Bigler

Abstract

This course conveys the basics of forest ecology with an emphasis on trees as those organisms that dominate the physiognomy and dynamics of forest ecosystems. Based on this course, students have a good grasp of the qualitative and quantitative importance of forest ecosystems at the global and regional scales, with a focus on central Europe.

Objective

Students are able to

- summarize the fundamentals of forest ecology at the autecological, demecological and synecological level
- explain, how trees dominate the physiognomy and dynamics of forest ecosystems
- describe the qualitative and quantitative importance of forest ecosystems at the global and regional scales, with an emphasis on central Europe and the European Alps.

Content

Introduction and overview of the forests of the world

Forest ecosystem ecology: Production ecology of forests

Autecology: light, temperature, wind, water, and nutrients

Demecology: regeneration ecology, forest growth, mortality

Synecology: Fundamentals of trophic interactions (forest-ungulate interactions, herbivory by insects), succession
By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.

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By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.

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By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.
A bachelor's thesis in "Natural sciences" deals with a topic at the interface of natural sciences, the environment and sustainability. The methods of data collection, analysis and interpretation appropriate to the natural sciences are used.

A thesis in "Engineering" deals with the environmental effects of use and application. The thesis may take the form of an analysis or review of a current technology, or the design of a future technological application. In an inter- or transdisciplinary thesis, knowledge from various fields and disciplines would be merged on the basis of an overarching question, or developed via the input of key societal actors.

A short bachelor's thesis should consist of a text, with graphs and figures, of 15-20 pages.

**Environmental Sciences Bachelor - Key for Type**

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Environmental Sciences Master

► Major in Atmosphere and Climate

►► Prerequisites

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0471-01L</td>
<td>Atmospheric Chemistry</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Ammann, D. W. Brunner</td>
</tr>
<tr>
<td>701-0471-01L</td>
<td>Weather Systems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. A. Sprenger, C. Grams</td>
</tr>
<tr>
<td>701-0471-01L</td>
<td>Numerical Methods in Environmental Sciences</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>C. Schär, O. Fuhrer</td>
</tr>
</tbody>
</table>

- **Abstract**: The lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.

- **Objective**: The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds. The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.

- **Content**: - Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
  - Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
  - Thermospheric photochemistry: Photolysis reactions, photochemical C3 formation, role and budget of HOx, dry and wet deposition
  - Aerosols and clouds: chemical properties, primary and secondary aerosol sources
  - Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols
  - Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends
  - Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
  - Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

- **Lecture notes / notice**: Vorlesungsunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.

- **Prerequisites / notice**: Attendance of the lecture "Atmosphäre" LV 701-0023-00L or equivalent is a pre-requisite.

- **Abstract**: This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

- **Objective**: The students are able to - explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
  - to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
  - to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
  - to explain how mountains influence the atmospheric flow on different scales

- **Content**: Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

- **Prerequisites / notice**: Vorlesungsunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.

- **Abstract**: This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.

- **Objective**: Students are able to - to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
  - to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

- **Content**: Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, clouds and precipitation

- **Prerequisites / notice**: Vorlesungsunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.

- **Abstract**: This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

- **Objective**: This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

- **Content**: Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

- **Prerequisites / notice**: Vorlesungsunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.

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Data: 06.12.2018 13:04  Autumn Semester 2015  Page 1365 of 1432
The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture) and processes in the Planetary Boundary Layer (PBL) that govern the surface climate. Theory on transport processes in the PBL and their dynamical processes is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer processes. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Powerpoint slides will be made available.

Prerequisites / notice
- Physics I, II, Environmental Fluid Dynamics
- Introduction, B. Sierau
- Microstructure of clouds and precipitation, aerosol activation to form cloud droplets, ice crystal nucleation (homogeneous freezing of supercooled aerosol and heterogeneous freezing), precipitation formation
- At least one introductory course in Atmospheric Science or Instructor's consent.

Climate Processes and Feedbacks

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>U. Lohmann, B. Sierau</td>
</tr>
<tr>
<td>701-1251-00L</td>
<td>Land-Climate Interactions</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. I. Seneviratne, E. L. Davin</td>
</tr>
<tr>
<td>651-4911-00L</td>
<td>Climate and the Global Circulation of the Atmosphere</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>T. Schneider</td>
</tr>
<tr>
<td>701-1299-00L</td>
<td>Physics and chemistry of clouds</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>U. Lohmann</td>
</tr>
</tbody>
</table>

Prerequisites / notice
- Understanding of the basic physical processes involved in maintaining the global circulation of the atmosphere and the surface climate (winds, temperature, precipitation, etc.). Ability to reason how climate may change on long timescales.

Prerequisites / notice

Lecture notes
- Powerpoint slides will be available.
Abstract
Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth's radiation balance. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes. In this course the sought-after topic of ice formation in clouds is studied from a theoretical and empirical perspective.

Objective
Students will be able to understand the microphysics cloud and precipitation formation. To this end, we will discuss the relevant chapters in the textbook of Lamb & Verlinde with the same title as this lecture.

Literature

Prerequisites / notice
An introductory course to Atmospheric Science
The students can understand the role of land processes and associated feedbacks for the climate system.

Lecturers
Hydrology II
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport
Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology.
Analysis of Climate and Weather Data
Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in
Nodes for hydrological models are discussed at the event and continuous scale. The focus is on the description of physical processes and
Glacial and Interglacials
Millennial-scale climate variability during glaciations
The last deglaciation(s)
The Younger Dryas
Holocene climate - climate and societies

Hydrology and Water Cycle

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1251-00L</td>
<td>Land-Climate Interactions</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. I. Seneviratne, E. L. Davin</td>
</tr>
<tr>
<td>Abstract</td>
<td>The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The students can understand the role of land processes and associated feedbacks for the climate system.</td>
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<tr>
<td>Lecture notes</td>
<td>Powerpoint slides will be made available</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Introductory lectures in atmospheric and climate science</td>
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</thead>
<tbody>
<tr>
<td>701-1253-00L</td>
<td>Analysis of Climate and Weather Data</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>C. Frei</td>
</tr>
<tr>
<td>Abstract</td>
<td>Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.</td>
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<td>Objective</td>
<td>Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.</td>
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</tr>
<tr>
<td>Content</td>
<td>Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology. Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.</td>
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<tr>
<td>Lecture notes</td>
<td>Documentation and supporting material include: documented view graphs used during the lecture - exercises sets and solutions - R-packages with software and example datasets for exercise sessions</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahes Programmieren.</td>
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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.</td>
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<tr>
<td>Objective</td>
<td>Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Parts of the script for &quot;Hydrology II&quot; are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.</td>
<td></td>
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<tr>
<td>Literature</td>
<td>Additional literature is presented during the course.</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4053-05L</td>
<td>Boundary Layer Meteorology</td>
<td>Z</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Rotach, P. Calanca</td>
</tr>
<tr>
<td>Abstract</td>
<td>The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.</td>
<td></td>
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</table>
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

Content
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Lecture notes available (i.e. in English)

Literature

Prerequisites / notice

Colloquia and Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1213-00L</td>
<td>Introduction Course to Master Studies Atmosphere and Climate</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. M. Fischer, T. Peter</td>
</tr>
</tbody>
</table>

Abstract
New master students are introduced to the atmospheric and climate research field through keynotes given by the programme's professors. In several self-assessment and networking workshops they get to know each other and find their position in the science.

Objective
The aims of this course are i) to welcome all students to the master program and to ETH, ii) to acquaint students with the faculty teaching in, T. Ewen, O. Stebler, E. M. Fischer, Colloquium Atmosphere and Climate 2

U. Lohmann

3 credits

ECTS

1 credit

1 credit

1 credit

1 credit

Master's Seminar: Atmosphere and Climate 1
701-1213-00L

Objective
The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Content
The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

Lecturers
- E. M. Fischer
- N. Gruber
- R. Knutti
- T. Peter
- C. Schär
- S. I. Seneviratne
- H. Wernli
- M. Wild

Master's Seminar: Atmosphere and Climate 2
701-1211-02L

Abstract
The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Objective
The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

Lecturers
- E. M. Fischer
- N. Gruber
- R. Knutti
- T. Peter
- C. Schär
- S. I. Seneviratne
- H. Wernli
- M. Wild

Master's Seminar: Atmosphere and Climate 3
701-1211-03L

Abstract
The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Objective
The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

Lecturers
- E. M. Fischer
- N. Gruber
- R. Knutti
- T. Peter
- C. Schär
- S. I. Seneviratne
- H. Wernli
- M. Wild

Electives
Climate Processes and Feedbacks

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

Abstract
Understanding the dynamics of large-scale atmospheric flow

Objective
Dynamic, synoptic Meteorology

Content
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Dynamics of large-scale atmospheric flow

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

651-4057-00L Climate History and Palaeoclimatology

Abstract
The course "Climate history and paleoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in paleoclimate research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Geological time, stratigraphy, geological archives, climate archives, paleoclimate proxies

Climate through geological time: "lessons from the past"

- Cretaceous greenhouse climate
- The Late Paleocene Thermal Maximum (PETM)
- Cenozoic Cooling
- Onset and Intensification of Southern Hemisphere Glaciation
- Onset and Intensification of Northern Hemisphere Glaciation
- Pliocene warmth
- Glacial and Interglacials
- Millennial-scale climate variability during glaciations
- The last deglaciation(s)
- The Younger Dryas

Holocene climate - climate and societies

Atmospheric Composition and Cycles

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>U. Lohmann, B. Sierau</td>
</tr>
</tbody>
</table>

Abstract
Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth’s radiation balance. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes. In this course the sought-after topic of ice formation in clouds is studied from a theoretical and empirical perspective.

Objective
Students will gain an appreciation and understanding of the complex processes in clouds and the necessary physical phenomenon that are involved and need to be accounted for in order to study cloud and precipitation formation.

Content
Microstructure of clouds and precipitation, aerosol activation to form cloud droplets, ice crystal nucleation (homogeneous freezing of supercooled aerosol and heterogeneous freezing), precipitation formation

Lecture notes
Powerpoint slides will be made available

Literature

Prerequisites / notice
At least one introductory course in Atmospheric Science or Instructor's consent.

102-0635-01L Air Pollution Control

Abstract
The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their im-pact on air quality. The second part covers different strategies and techniques for emis-sion reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society.

Objective
The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. The students know the different techniques of air pollution control and their scientific basesement. They are able to incorporate goals concerning the air quality into their engineering work.
Part 1 Emission, Immission, Transmission
- Fluxes of pollutants and their environmental impact
- physical and chemical processes leading to emission of pollutants
- mass and energy of processes
- Emission measurement techniques and concepts
- quantification of emissions from individual and aggregated sources
- extent and development of the emissions (Switzerland and global)
- propagation and transport of pollutants (transmission)
- meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- dispersion models (Gaussian model, box model, receptor model)
- measurement concepts for ambient air (immission level)
- extent and development of ambient air mixing ratios
- goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (process-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration, electrostatic precipitators, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms.
- Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
- Discussion of the technical possibilities to solve the actual air pollution problems.

Lecture notes
- Brigitte Buchmann, Air pollution control, Part I
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises

Literature
- List of literature included in scrip

Prerequisites / notice
- College lectures on basic physics, chemistry and mathematics

651-4053-05L Boundary Layer Meteorology W 4 credits 3G M. Rotach, P. Calanca
Abstract
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

Objective
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

Content
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Lecture notes
available (i.e. in English)

Literature

Prerequisites / notice
- Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

Hydrology and Water Cycle

Number Title ECTS Hours Lecturers
701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology W 3 credits 2G+2U D. Or
Abstract
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
Weeks 1 to 3: Physical Properties of Soils and Other Porous Media  
Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior.

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity.

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing.

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow.

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils  
Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone  
An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bi- and phytoremediation.

Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester) http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

102-0287-00L Fluvial Systems W 3 credits 2G P. Molnár

Abstract

The course presents an integrated view of the river basin and fluvial system. The fluvial system is viewed in terms of the dynamics in the transfer of water and sediment, the resulting geomorphology of the river network and streams, and finally the basin and river management options for conservation and restoration.

Objective

The goal of the course is to develop process-understanding of fluvial systems and to introduce the students to appropriate analysis tools. In the first section the estimation of basin sediment supply from upland sheet, rill and gully erosion, and basin sediment yield are discussed. The second section focuses on sediment transport in rivers in general, e.g. basic mechanics of sediment laden flows, bedforms, flow resistance, sediment type and load measurement and estimation, the morphology of rivers. It is illustrated how the river network can be analysed in terms of its connectivity and topological characteristics. Channel stability and channel erosion modelling are discussed. The third section looks at fluvial system management in terms of engineering and nonstructural sediment (e.g. upland and channel erosion protection) and water (e.g. the importance of the natural streamflow regime on riverine ecosystem integrity, river rehabilitation) resource management.

Lecture notes

There is no script.

Literature

Study materials (lecture handouts and selected papers) are distributed in class and available on the web.

Prerequisites / notice

Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

651-2915-00L Seminar in Hydrology Z 0 credits 1S P. Burlando, J. W. Kirchner, S. Low, D. Or, G. Schär, M. Schirmer, S. I. Seneviratne, M. Stähli, C. H. Stamm, University lecturers

651-4023-00L Groundwater W 4 credits 3G M. O. Saar, X.Z. Kong

Abstract

The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective

a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.
1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.

2. Flow equation. The generalized Darcy law.

3. The water balance equation.


5. Analytical solutions to flow problems I

6. Analytical solutions to flow problems II

7. Finite difference solution to flow problems.


12. Analytical solutions to transport problems I.

13. Analytical solutions to transport problems II


Lecture notes

Handouts of slides.

Script in English is planned.


de Marsily G., Quantitative Hydrogeology, Academic Press, 1986

►►► Additional Elective Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-1237-00L</td>
<td>Solar Ultraviolet Radiation</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>J. Gröbner</td>
</tr>
</tbody>
</table>

Abstract

The lecture will introduce the student to the thematics of solar ultraviolet radiation and its effects on the atmosphere and the biosphere. The lecture will cover the modeling and the measurement of solar ultraviolet radiation. The instruments used for solar radiation measurements will also be introduced.

Objective

The lecture should enable the student to understand the specific problematics related to solar ultraviolet radiation and its interaction with the atmosphere and the biosphere.
1) Einführung in die Problematik  Motivation
   Begriffe (UV-C, UV-B, UV-A,...)
   Einfluss der UV Strahlung auf Biosphäre (Mensch, Tier, Pflanzen)
   Positive und schädliche Effekte
   Wirkungsspektrum, Konzept, Beispiele
   UVIndex:

2) Geschichtlicher Rückblick
   Rayleigh - Himmelsblau
   1907: Dorno, PMOD
   1970: Bener, PMOD
   1980: Berger, Erythemal sunburn meter
   1990+: State of the Art

3) Extraterrestrische UV Strahlung
   Spektrum
   Energieverteilung
   Variabilität (Spektral, zeitlich, relativ zu Totalstrahlung)
   Satellitenmessungen, Übersicht

4) Einfluss der Atmosphäre auf die solare UV Strahlung
   Atmosphärenaufbau
   Beinflussende Parameter (Ozon, Wolken, ...)
   Ozon, Stratosphärisches versus troposphärisches
   Geschichte: Ozondepletion, Polare Ozonlöcher und Einfluss auf die UV Strahlung
   Wolken
   Aerosole
   Rayleighstreuung
   Trends (Ozon, Wolken, Aerosole)
   Radiation Amplification Factor (RAF)

5-6) Strahlungstransfer
   Strahlungstransfergleichung
   Modellierung, DISORT
   LibRadtran, TUV, FASTRT
   Parameter
   Sensitivitätsstudien
   Vergleiche mit Messungen
   3-D Modellierung (MYSTIC)
   Beer-Lambert Gesetz

7) Strahlungsmessungen
   Instrumente zur Strahlungsmessung
   Messgrössen: Irradiance (global, direct, diffus), radiance, aktinischer Fluss
   Horizontale und geneigte Flächen
   Generelle Problematik: Freiluftmessungen...
   Qualitätssicherung

8) Solare UV Strahlungsmessungen
   Problematik: Dynamik, Spektrale Variabilität, Alterung
   Stabilität
   Spezifische Instrumente: Filterradiometer, Spektroradiometer, Dosimetrie
   Übersicht Aufbau und Verwendung

9-10) Solare UV Strahlungsmessgeräte
   Spektroradiometer, Filterradiometer (Breit und schmalbandig)
   Charakterisierung
   Kalibriermethoden (Im Labor, im Feld)
   Qualitätssicherung, Messkampagnen

11-12) Auswerteverfahren
   Atmosphärische Parameter aus Strahlungsmessungen
   Ozon, SO2
   Albedo (Effektiv versus Lokal)
   Aerosol Parameter (AOD, SSA, g, Teilchenverteilungen)
   Zusammenspiel Messungen - Modellierung
   Aktinische UV-Strahlungsf läue und Bestimmung von atmosphärischen Photolysefrequenzen

13) UV Klimatologie
   Trends
   UV Klimatologie durch Messnetze
   UV Klimatologie durch Satellitenmessungen am Beispiel von TOMS
   Modellierung am Beispiel Meteosat-JRC
   UV Rekonstruktionen

14) Aktuelle Forschungen
   Internationale Projekte, Stand der Forschung

651-4273-00L  Numerical Modelling in Fortran  W  3 credits  2V  P. Tackley

Abstract
This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming
experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on
approach will be emphasized rather than abstract concepts.

Objective
FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives
an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example
with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A
hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

Lecture notes
See http://jupiter.ethz.ch/~pjt/FORTRAN/FortranClass.html

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment.

FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

**Biogeochemical Processes**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tr>
<td>701-1313-00L</td>
<td>Isotopic and Organic Tracers in Biogeochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>Kipfer, Schubert</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course &quot;Isotopic and Organic Tracers Laboratory&quot;.</td>
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<tr>
<td>Objective</td>
<td>The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications</td>
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<tr>
<td>Content</td>
<td>Geogenic and cosmogenic radionuclides (sources, decay chains); stable isotopes in biogeochemistry (natural abundance, fractionation); geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts will be provided for every chapter</td>
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<tr>
<td>Literature</td>
<td>A list of relevant books and papers will be provided</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent)</td>
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<tr>
<td>701-1315-00L</td>
<td>Biogeochemistry of Trace Elements</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Voegelin, J. G. Wiederhold, L. Winkel</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course addresses major biogeochemical processes that drive the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.</td>
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<tr>
<td>Objective</td>
<td>The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.</td>
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<tr>
<td>Content</td>
<td>The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.</td>
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<tr>
<td>Lecture notes</td>
<td>Selected handouts (lecture notes, literature, exercises) will be distributed during the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.</td>
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This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

**Applications**

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<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.</td>
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<tr>
<td>Objective</td>
<td>The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.</td>
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<tr>
<td>Content</td>
<td>The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts will be distributed</td>
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<tr>
<td>Literature</td>
<td>Will be mentioned in handouts</td>
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<tbody>
<tr>
<td>701-1346-00L</td>
<td>Carbon Mitigation</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>N. Gruber</td>
</tr>
<tr>
<td>Abstract</td>
<td>The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.</td>
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<tr>
<td>Content</td>
<td>From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.</td>
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<tr>
<td>Lecture notes</td>
<td>None</td>
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<tr>
<td>Literature</td>
<td>Will be identified based on the chosen topic.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.</td>
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Methods and Tools: Lab Courses

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<tr>
<td>701-1331-00L</td>
<td>Trace Elements Laboratory ■</td>
<td>W</td>
<td>3</td>
<td>4P</td>
<td>K. Barmettler, A. L. Atkins</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>The course offers a practical introduction into the investigation of the biogeochemistry of trace elements. Laboratory experiments are performed to study a selected environmental process. Advanced techniques for the analysis of total element contents and element speciation are used. The experimental findings are interpreted and discussed in their environmental context.</td>
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<td></td>
<td>Objective</td>
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<td>In this course, the students become familiar with some experimental approaches for the investigation of the biogeochemistry of trace elements in the laboratory and learn to use different advanced analytical techniques to measure the total content and the speciation of trace elements in liquid and solid samples. The students learn to interpret and discuss their experimental findings in the context of the studied environmental system.</td>
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<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>The course offers a practical introduction into the investigation of the biogeochemistry of trace elements. Laboratory experiments are designed and performed to study a biogeochemical process. Advanced techniques for the analysis of total element contents and element speciation are used. The experimental findings are interpreted and discussed in the context of the environmental system under investigation.</td>
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<td></td>
<td>Lecture notes</td>
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<td></td>
<td>Selected handouts will be distributed during the course.</td>
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<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>Prerequisite: Lecture Biogeochemistry of Trace Elements</td>
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</tbody>
</table>

| 701-1333-00L | Isotopic and Organic Tracers Laboratory ■ | W    | 3    | 4P    | C. Schubert, R. Kipfer    |
|              | Abstract                                  |      |      |       |                            |
|              | This course will illustrate how different tracers and isotopes are used in natural systems. Here especially the processes (transformation, timescales) that take place and can be revealed by tracers/isotopes will be demonstrated but also flux rates will be calculated using different tracers. |
|              | Objective                                 |      |      |       |                            |
|              | Students know how to use tracers/isotopes to investigate/understand ecosystems     |
|              | They will understand the methods and analytical devices related to tracer/isotope work |
|              | Have a feeling for timescales on which natural processes occur                       |
|              | Students will be able to apply different sampling techniques in aquatic sciences   |
This class is the 2nd part of a series and participation is conditional on the successful completion of the Term paper Writing class (701-1303-00L).

Soil Solids Laboratory

None

Selected handouts will be distributed during the course.

The ability to critically evaluate original (scientific) literature and to summarize the information in a succinct manner is an important skill for any student. This course aims to practise this ability, requiring each student to write a term paper on a topic of relevance for research in the areas of biogeochemistry and pollutant dynamics.

Term Paper 2: Seminar

Hours

W 3 credits 6P

F. Hagedorn, E. Graf Pannatier, P. F. Schlegli

Forest Soils - Functions and Responses to Environmental Changes

Abstract

The students are measuring carbon and nutrient fluxes in forest soils under a changing climate and land-use. In laboratory and field experiments, they are manipulating climate conditions (temperature, drought) and quantify the response of C and N fluxes in soils, and plant-soil interactions. The results will be interpreted and discussed in the context of changes in climate and land-use.

Objective

The students get first-hand experience with field and laboratory methods to measure carbon and nutrient fluxes. They shall learn about physico-chemical properties of Swiss forest soils and how these properties determine the ecological functions of soils and their response to environmental changes. Finally the students shall interpret, discuss and present their experimental data.

Content

1. Introduction to the ecological functions of Swiss forest soils
2. Measurement of soil CO2 efflux, carbon and nutrient leaching in a forest soil
3. Sampling and preparation of litter and soil samples from selected soil profiles under different land-uses
4. Setting-up laboratory experiments in microcosms. Measurement of soil respiration and leaching of carbon, nutrients and/or contaminants in climate chambers under different environmental conditions.
5. Analyses of litter, soil, and soil water for selected physical and chemical properties
6. Interpretation and final presentation of data

Lecture notes

A manual will be distributed during the course.

Literature

Selected publications will be distributed during the course.

Term Paper 1: Writing

6G


Semester Paper and Seminar

Number Title Type ECTS Hours Lecturers


Abstract

This class is the 2nd part of a series and participation is conditional on the successful completion of the Term paper writing class (701-1303-00L). The results from the term paper written during the winter term are presented to the other students and advisors and discussed.

Objective

The goal of the term paper Seminars is to train the student's ability to communicate the results to a wider audience and the ability to respond to questions and comments from the audience.

Content

Each student presents the results of the term paper to the other students and advisors and responds to questions and comments from the audience.

Lecture notes

None

Literature

Term paper

Prerequisites / notice

The term papers will be made publically available after each student had the opportunity to make revisions.

There is no final exam. Grade is assigned based on the quality of the presentation and ensuing discussion.


Abstract

The ability to critically evaluate original (scientific) literature and to summarize the information in a succinct manner is an important skill for any student. This course aims to practical this ability, requiring each student to write a term paper on a topic of relevance for research in the areas of biogeochemistry and pollutant dynamics.
**Electives**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0534-00L</td>
<td>Chemical Kinetics in Terrestrial and Aquatic Systems</td>
<td>W</td>
<td>1 credit</td>
<td>2G</td>
<td>S. Krämer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction in mechanisms of kinetically controlled processes in terrestrial and aquatic systems and their quantitative treatment</td>
<td></td>
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<tr>
<td>Content</td>
<td>Theory of reaction kinetics. Derivation of rate laws. Evaluation of experimental data. Estimation of reaction rates from field observation. Mechanisms of kinetically controlled processes such as reactions in the aquatic phase (complexation, redox processes); mineral surface reactions (adsorption, dissolution, precipitation, redox processes); reactions at gas/water interfaces; photochemical reactions; microbial/enzymatic reactions; reactions in stratified environments (soils, sediments).</td>
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</tr>
<tr>
<td>Literature</td>
<td>Distribution during lecture and on a course web-page</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Lecture for advanced and doctoral students. Course language is English. Lecture will be taught as a block in February. Exact dates will be announced.</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Advanced Topics in Environmental Interface</th>
<th>W</th>
<th>1 credit</th>
<th>2G</th>
<th>S. Krämer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>We will discuss interfacial processes and mechanisms by which microorganisms and plants interact with their extracellular environment, particularly with mineral surfaces.</td>
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<tr>
<td>Content</td>
<td>Students will become acquainted with interfacial biogeochemistry of bio-mineral Interactions.</td>
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</tr>
<tr>
<td>Literature</td>
<td>none</td>
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<tr>
<td>- Phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and phylodynamics. The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we use the models and methods closely with publications, mainly in the field of epidemiology and evolution.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The Lecture will be taught as a 4-day block in February. Exact dates will be announced.</td>
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</table>

**Major in Ecology and Evolution**

**A. Principles**

<table>
<thead>
<tr>
<th>Number</th>
<th>Research Seminar: Ecological Genetics</th>
<th>W</th>
<th>2 credits</th>
<th>1S</th>
<th>A. Widmer, S. Fior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.</td>
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<tr>
<td>Objective</td>
<td>It is our aim that participants gain insight into the current research topics and knowledge available in Ecological Genetics and learn to critically assess and appreciate scientific publications in this field.</td>
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<tr>
<td>Lecture notes</td>
<td>none</td>
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<tr>
<td>Literature</td>
<td>will be distributed</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Active participation in the discussions is a prerequisite for this course.</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Molecular Evolution, Phylogenetics and Phylodynamics</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>T. Stadler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.</td>
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<tr>
<td>Objective</td>
<td>Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are: * models in molecular evolution * phylogenetic &amp; phylodynamic inference * maximum likelihood and Bayesian statistics * stochastic processes</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Attendees will apply these concepts to a number of applications yielding biological insight into: * epidemiology * pathogen evolution * macroevolution of species</td>
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</tbody>
</table>
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models on macroevolution are illustrated on different datasets, giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Prerequisites / notice

Online course

Language: English

Content

Lecture notes

Slides of the lecture will be available online.

Literature

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Basic knowledge in linear algebra, analysis, and statistics.

701-0263-01L Seminar in Evolutionary Ecology of Infectious Diseases

Objective

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Abstract

Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

Literature

This six-day winter school aims at teaching advanced Master students, PhD students and postdocs on landscape genetics. It provides both theoretical background as well as hands-on exercises on major topics of contemporary landscape genetics and landscape genomics such as landscape effects on dispersal and gene flow and adaptive genetic variation in a landscape context.

Prerequisites / notice

Online course

Course language is English

Content

The course is strongly interdisciplinary and the various approaches are designed to help understand the past, present and future of mountain ecosystems.

Abstract

The online course ALPECOLe provides a global overview of the complex ecosystems of mountain regions, and of their great diversity of habitats and organisms. The course is subdivided into:

- 5 lessons on abiotic factors: geology, soils and their forming processes, climate, and disturbance factors
- 12 lessons on plants: diversity, patterns and processes, tree lines, water & nutrients, carbon cycle, atmospheric influences, sexual and clonal reproduction, and one specific lesson on aquatic environments
- 5 lessons on animals: habitats and adaptations, origin of species, food ecology and impact of domestic livestock
- 3 lessons on landscape evolution: quaternary paleoenvironments, methods like radiocarbon dating, pollen records, dendrochronology, stable isotopes, and historical data
- 1 lesson on global change

Content

Landscape genetics is an evolving scientific field of both basic and applied interest. Researchers as well as conservation managers make increasing use of landscape genetic thinking and methods. Landscape genetics builds on concepts and methods from landscape ecology and population genetics. This winter school introduces advanced students to major concepts and methods of landscape genetics and genomics, i.e. (i) the study of landscape effects on dispersal and gene flow and (ii) the study of the interactions between the environment and adaptive genetic variation. The winter school focuses on currently used methods and hands-on exercises. It is specifically aimed at the needs of advanced students (Master, PhD and postdocs).

Abstract

This six-day winter school aims at teaching advanced Master students, PhD students and postdocs on landscape genetics. It provides both theoretical background as well as hands-on exercises on major topics of contemporary landscape genetics and landscape genomics such as landscape effects on dispersal and gene flow and adaptive genetic variation in a landscape context.

Objective

Landscape genetics builds on concepts and methods from landscape ecology and population genetics. This winter school introduces advanced students to major concepts and methods of landscape genetics and genomics, i.e. (i) the study of landscape effects on dispersal and gene flow and (ii) the study of the interactions between the environment and adaptive genetic variation. The winter school focuses on currently used methods and hands-on exercises. It is specifically aimed at the needs of advanced students (Master, PhD and postdocs).

Content

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models on macroevolution are illustrated on different datasets, giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Prerequisites / notice

Online course

Course language is English

Content

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Basic knowledge in linear algebra, analysis, and statistics.

701-0263-01L Seminar in Evolutionary Ecology of Infectious Diseases

W 3 credits 2G D. Croll, S. Bonhoeffer, R. R. Regös

Abstract

Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

Objective

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Content

A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Literature

Publications and class notes can be downloaded from a web page announced during the lecture.

701-1441-00L Alpine Ecology and Environments

W 2 credits 2G S. Dietz, D. Ramseier

Abstract

The online course ALPECOLe provides a global overview of the complex ecosystems of mountain regions, and of their great diversity of habitats and organisms. The course is subdivided into:

- 5 lessons on abiotic factors: geology, soils and their forming processes, climate, and disturbance factors
- 12 lessons on plants: diversity, patterns and processes, tree lines, water & nutrients, carbon cycle, atmospheric influences, sexual and clonal reproduction, and one specific lesson on aquatic environments
- 5 lessons on animals: habitats and adaptations, origin of species, food ecology and impact of domestic livestock
- 3 lessons on landscape evolution: quaternary paleoenvironments, methods like radiocarbon dating, pollen records, dendrochronology, stable isotopes, and historical data
- 1 lesson on global change

Content

Students can also follow a virtual walk through alpine areas where context-based information on alpine environments can be accessed. Moreover, all mayor alpine areas of the world can be selected on a map and then informative pictures of those landscapes and faunistic and floriastic inhabitants will be shown.

Online exercises and tests allow to test the learned matter.

Additionally to the online lessons, three supplementary papers will be read and discussed during the tutorials.

Literature

Online exercises and tests allow to test the learned matter.

Prerequisites / notice

Online course

Course language is English

701-1676-01L Landscape Genetics

Number of participants limited to 14.

W 2 credits 3G R. Holderegger, J. Bolliger, F. Gugerli

Prerequisites: good knowledge in population genetics and experience in using GIS is required.

Abstract

This six-day winter school aims at teaching advanced Master students, PhD students and postdocs on landscape genetics. It provides both theoretical background as well as hands-on exercises on major topics of contemporary landscape genetics and landscape genomics such as landscape effects on gene flow and adaptive genetic variation in a landscape context.

Objective

Landscape genetics is an evolving scientific field of both basic and applied interest. Researchers as well as conservation managers make increasing use of landscape genetic thinking and methods. Landscape genetics builds on concepts and methods from landscape ecology and population genetics. This winter school introduces advanced students to major concepts and methods of landscape genetics and genomics, i.e. (i) the study of landscape effects on dispersal and gene flow and (ii) the study of the interactions between the environment and adaptive genetic variation. The winter school focuses on currently used methods and hands-on exercises. It is specifically aimed at the needs of advanced students (Master, PhD and postdocs).

Content

Themes:

(1) Genetic data: estimates of gene flow; genetic distances; assignment tests and parentage analysis.
(2) Landscape data: landscape resistance and least cost paths; transects
(3) Landscape genetic analysis of gene flow: partial Mantel tests and causal modeling; multiple regression on distance matrices and mixed effects models.
(4) Networks and graph theory.
(5) Landscape genomics: adaptive genetic variation; outlier detection; environmental association.
(6) Overlays: Bayesian clustering; barrier detection; kriging.

Lecture notes

Hand-outs will be distributed.

Literature

The course requires 4 hours of preparatory reading of selected papers on landscape genetics. These papers will be distributed by e-mail.

Prerequisites / notice

Grading will be according to a short written report (4 pages) on one of the themes of the course (workload: about 8 hours) and according to student contributions during the course.

Prerequisites: students should have basic knowledge in population genetics, GIS and R.

751-5101-00L Biogeochemistry and Sustainable Management

W 2 credits 2G L. Merbold, N. Buchmann

Abstract

This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled human-ecological systems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

Data: 06.12.2018 13:04
Autumn Semester 2015
Page 1379 of 1432
Objective
Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

Content
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

Lecture notes
Handouts will be available on the webpage of the course.

Literature
Will be discussed in class.

Prerequisites / notice
Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.

751-4805-00L Recent Advances in Biocommunication

Abstract
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

Objective
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

B. Applications

Applications to Conservation and Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1453-00L</td>
<td>Ecological Assessment and Evaluation</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>F. Knaus, U. Bollens Hunziker</td>
</tr>
<tr>
<td>701-1613-01L</td>
<td>Advanced Landscape Research</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>M. Bürgi, J. Bolliger, U. Gimmi, M. Hunziker</td>
</tr>
</tbody>
</table>

Objective
Students will:
- learn about concepts and methods to quantify structural and functional connectivity in landscapes, particularly
- be introduced to the topic of landscape genetics and its benefits and (current) limitations for applied conservation
- learn about concepts and methods in scenario-based land-use change modelling
- approach an understanding of landscape as perceived environment
- learn about concepts of landscape preference and related measurement methods
- understand the role of landscape for human well-being
- be introduced into approaches of actively influencing attitudes and behavior as well as related scientific evaluation
- make use of various historical sources to study landscapes and their dynamics
- interpret landscapes as a result of ecological constraints and anthropogenic activities.

Notes
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

Objective
Students will be able to:
1) critically consider biological data books and local, regional, and national inventories;
2) evaluate the validity of ecological criteria used in decision making processes;
3) critically appraise the handling of ecological data and criteria used in the process of evaluation
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

Lecture notes
Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

Literature
Basic literature and references are listed on the webpage.

Prerequisites / notice
The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.

Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbioökologie

This course introduces landscapes as socially perceived, spatially and temporally dynamic entities that are shaped by natural and societal factors. Concepts and qualitative and quantitative methods to study landscapes from an ecological, societal and historical perspective are presented. In a term paper students work on a landscape-related topic of their choice.

Students will:
- learn about concepts and methods to quantify structural and functional connectivity in landscapes, particularly
- be introduced to the topic of landscape genetics and its benefits and (current) limitations for applied conservation
- learn about concepts and methods in scenario-based land-use change modelling
- approach an understanding of landscape as perceived environment
- learn about concepts of landscape preference and related measurement methods
- understand the role of landscape for human well-being
- be introduced into approaches of actively influencing attitudes and behavior as well as related scientific evaluation
- make use of various historical sources to study landscapes and their dynamics
- interpret landscapes as a result of ecological constraints and anthropogenic activities.
This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake. Students should be able to:

- a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.
- b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Lecture notes
No Script

Literature
This course provides training for advanced students (master, doctoral or post-doctoral level) in how to measure and collect genetic diversity.

Prerequisites
- Basic statistical training (e.g. Mathematik IV in D-USYS): Data distributions, descriptive statistics, hypothesis testing, linear regression, analysis of variance
- Basic experience in data handling and data analysis in R

Individual preparation
Students without the required knowledge are asked to contact the lecturer before Christmas for support with individual preparation.

### Laboratory and Field Expertise

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1437-00L</td>
<td>Limnoecology</td>
<td>W</td>
<td>8 credits</td>
<td>10G</td>
<td>P. Spaak, F. Altermatt, T. Gonser, K. J. Räsänen, C. T. Robinson</td>
</tr>
</tbody>
</table>

#### Abstract
This course combines Limnology (the study of inland waters in its broad sense) with Ecological and Evolutionary concepts. It deals with rivers, groundwater and lakes. This course contains a lecture part, an experimental part as well as 1-day excursions.

#### Objective
During this course you will get an overview of the world's typical freshwater ecosystems. After this course you will be able to understand how aquatic organisms have adapted to their habitat, and how the interactions (e.g. food web) between organisms work.

During the experimental part of this course you will learn the principles of doing research to observe interrelations in aquatic ecosystems. You will measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge.

In short: apply the theoretical / lecture knowledge to field situations in a lake and river.

#### Content
The lecture part covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwater species: Applied case studies and experiments testing ecological and evolutionary processes in freshwater ecosystems.

The lectures are given by Piet Spaak (Eawag), Florian Altermatt (UNI, Eawag), Tom Gonser (Eawag), Katja Rårsän (Eawag) and Chris Robinson (Eawag), specialists from the Aquatic Ecology department of Eawag and University of Zurich.

#### Practical part
- The practical part contains 1-day excursions to a lake (Greifensee) and rivers (Sense, Töss) as well as research projects in small groups within research groups at Eawag.
- The practical part includes an assessment of the ecological state of lake Greifensee and the streams Glatt and Chriesbach. On this practical part you will work with survey methods used in research and practice.

### Expertise in Biological Diversity

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1425-01L</td>
<td>Genetic Diversity: Techniques</td>
<td>W</td>
<td>1 credit</td>
<td>2U</td>
<td>A. M. Minder Pfyl</td>
</tr>
</tbody>
</table>

#### Abstract
This course provides training for advanced students (master, doctoral or post-doctoral level) in how to measure and collect genetic diversity data from populations, experiments, field and laboratory. Different DNA/RNA extraction, genotyping and gene expression techniques will be addressed. Choice of topic by demand and/or availability of data. A course for practitioners.

#### Objective
To learn and improve on standard and modern methods of genetic data collection. Examples are: use of pyrosequencing, expression analysis, SNP-typing, next-generation sequencing, etc. A course for practitioners.

#### Content
After an introduction (one afternoon), students will have 3 weeks to work independently or in groups through different protocols. At the end of the whole group meets for another afternoon to present the techniques/results and to discuss the advantages and disadvantages of the different techniques.

Techniques addressed are: RNA/DNA extractions and quality control, SNP genotyping, pyrosequencing, real-time qPCR.

#### Literature
Material will be handed out in the course.

#### Prerequisites
Two afternoons are held in the class. The lab work will be done from the students according to their timetable, but has to be finished after 3 weeks. Effort is roughly 1-2 days per week, depending on the skills of the student.

### Expertise in Biological Diversity

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<th>Number</th>
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<tbody>
<tr>
<td>701-1437-01L</td>
<td>Practical Course Macroinvertebrates</td>
<td>W</td>
<td>2 credits</td>
<td>2P</td>
<td>J. Jokela</td>
</tr>
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</table>

This course gave an overview of the typical aquatic macroinvertebrate groups in Switzerland. Beside a theoretical background on the different groups the focus was laid on the determination of the most important species groups and their indentity keys, also using identification keys. Practical experience in bentic sampling techniques was collected during an excursion.

#### Objective
During this course you will get an overview of the typical aquatic macroinvertebrate groups in Switzerland and the common sampling techniques.

After this course you will be able to identify the most important aquatic species groups at the level of order/family and know the most important identification traits. You will also be able to use identification literature commonly used in Switzerland.

During an excursion, you will apply the theoretical identification knowledge to field situations.
The taxonomic part will cover microinvertebrates and cryptogams. The goal is to get to know the most common aquatic taxa in Switzerland, and to identify them with commonly used identification literature, and to get an idea how these organisms are used in research and practice. (language: German, translation of the most important things during the course possible)

The field excursion takes place Wednesday 21.10.2015.

**Prerequisites / notice**
The maximal participating number of students is 8 from D-USYS and 14 from D-BIOL. In case of too many students, those that simultaneously participate in the courses "701-1437-00 Limnoecology" and "701-1437-02 Bestimmungskurs aquatische Mikroinvertebraten und Kryptogamen" are given priority. Sign in until 10.9.2015, free places will be distributed 11.9.2015.

The field excursion takes place Wednesday afternoon 15.10.2014 from 13-17.

### C. Term Paper and Seminar

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<th>Number</th>
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<th>Lecturers</th>
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</table>

**Abstract**
Individual writing of an essay-type review paper about a specialized topic in the field of ecology and evolution, based on substantial reading of original literature and discussions with a senior scientist. Students will:
- choose a topic
- search and read appropriate literature
- develop a personal view on the topic and structure their arguments
- prepare figures and tables to represent ideas or illustrate them with examples
- write a clear, logical and well-structured text
- refine the text and present it according to professional standards

In all steps, they will benefit from the advice and detailed feedback given by a senior scientist acting as personal tutor of the student.

**Lecture notes**
Reading of articles in scientific journals

### Electives

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0205-00L</td>
<td>Challenges in Plant Sciences</td>
<td>W</td>
<td>2</td>
<td>2K</td>
<td>W. Gruissem, C. De Moraes, A. Rodriguez-Villalon, J. Six, further lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
The colloquium introduces students to the disciplines in plant sciences and provides integrated knowledge from the molecular level to ecosystems and from basic research to applications, making use of the synergies between the different research groups of the PSC. The colloquium offers a unique chance to approach interdisciplinary topics as a challenge in the field of plant sciences.

**Objective**
Major objectives of the colloquium are:
- introduction of graduate students and Master students to the broad field of plant sciences
- promotion of an interdisciplinary and integrative teaching program
- promotion of active participation and independent work of students
- promotion of presentation and discussion skills
- increased interaction among students and professors

**Content**
Challenges in Plant Sciences will cover the following topics:
- Chemical communication among plants, insect and pathogens.
- Specificity in hormone signaling.
- Genetic networks.
- Plant-plant interactions.
- Resilience of tropical ecosystems.
- Regulatory factors controlling cell wall formation.
- Chlorophyll breakdown.
- Innate immunity.
- Disease resistance genes.
- Sustainable agroecosystems.

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<tbody>
<tr>
<td>751-4504-00L</td>
<td>Plant Pathology I</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>F. Talas, B. McDonald, J. Palma Guerrero, A. Sanchez Vallat</td>
</tr>
</tbody>
</table>
Abstract
Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.

Objective
Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.

Content
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

Week 2  The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrphs, disease cycles and pathogen life cycles. Nematec attack strategies and types of damage.


Week 5  Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

Week 6  Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

Week 7  Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

Week 8  Pathogen effects on food quality and safety.

Week 9  Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

Week 10  Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

Week 11  Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

Week 12  Strategies for minimizing disease risks: principles of disease control and management.

Week 13  Disease control strategies: economic thresholds, physical control methods.

Week 14  Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

Lecture notes
Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

701-0290-00L Seminar in Microbial Evolution and Ecology (HS)  Z  0 credits  2S  S. Bonhoeffer

Seminar of the groups Ackermann, Bonhoeffer, Schmid-Hempel, Velicer. Talks given by members of these groups and external visitors.

In-depth introduction into microbial evolution and ecology, especially the aspects that are the focus of on-going research in this area at D-USYS.

► Major in Human-Environment-Systems
Students can register for the Major in Human-Environment-Systems in autumn semester 2015 for the last time.

►► Natural and Technological Systems

►►► Environmental Assessment

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>102-0317-00L</td>
<td>Advanced Environmental Assessments</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Hellweg, R. Frischknecht</td>
</tr>
</tbody>
</table>
|             | Advanced Environmental, Social and Economic Assessments (6KP) and 102-0317-00
|             | Advanced Environmental Assessments (3KP) cannot be chosen both. 102-0317-00 is already included in 102-0307-00. |

Abstract
This course deepens students' knowledge of the environmental assessment methodologies and their various applications.

Objective
This course has the aim of deepening students' knowledge of the environmental assessment methodologies and their various applications. In particular, students completing the course should have the
- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers
Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modelling, Material Flow Analysis.

### Landscape and Ecosystems

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<tbody>
<tr>
<td>701-1453-00L</td>
<td>Ecological Assessment and Evaluation</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>F. Knaus, U. Bollens Hunziker</td>
</tr>
<tr>
<td>701-1631-00L</td>
<td>Foundations of Ecosystem Management</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>J. Ghazoul, C. Garcia</td>
</tr>
</tbody>
</table>

**Abstract**

The course provides methods and tools for ecological evaluations dealing with natural conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objects and accuracy of the available tools and procedures. Birds and plants are used as main examples guiding through different case studies.

**Objective**

- Students will be able to:
  1. critically consider biological data books and local, regional, and national inventories;
  2. evaluate the validity of ecological criteria used in decision making processes;
  3. critically appraise the handling of ecological data and criteria used in the process of evaluation;
  4. perform an ecological evaluation project from the field survey up to the decision making and planning.

**Content**

- Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental wellbeing. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

**Lecture notes**

No Script
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications.

The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assess the key features of environmental governance by examining various practical environmental policy examples.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are the key elements of ‘environmental governance’ and how legitimate and effective are these approaches in addressing persistent environmental challenges?

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy).

Literature


Prerequisites / notice

A detailed course schedule will be made available at the beginning of the semester.

Number Title Type ECTS Hours Lecturers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1651-00L</td>
<td>Environmental Governance</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Lieberherr, G. de Buren</td>
</tr>
<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>T. Bernauer</td>
</tr>
</tbody>
</table>
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation, various examples of international environmental politics are discussed: the management of international water resources, the problem of nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

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<tbody>
<tr>
<td>W</td>
<td>851-0735-11L</td>
<td>Environmental Regulation: Law and Policy</td>
<td>3</td>
<td>1S</td>
<td>J. van Zeben</td>
</tr>
</tbody>
</table>

**Objective**

The aim of the course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

**Content**

Topics covered in lectures:

1. Environmental Regulation
   a. Perspectives
   b. Regulatory Challenges of Environment Problems
   c. Regulatory Tools
2. Law: International, European and national laws
   a. International law
   b. European law
   c. National law
3. Policy: Case studies

**Assessment:**

(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

**Lecture notes**

A course taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped, and no specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project. An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0745-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

**Integrative Approaches and Transdisciplinary and Sustainable Development**

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects.Td methods are used in research at the science-society interface and when collaborating across scientific disciplines. Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.
At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods
- Analysis of a selected number of transdisciplinary methods focusing on problem framing, problem analysis, and impact
- Analysis of a selected number of transdisciplinary methods focusing on problem framing, problem analysis, and impact

Understand:
- Functional application in case studies and other problem-oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2016

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

At the end of the course, students should:

Know:
- Core concepts of sustainable development, and;
- The concept of social justice - normatively and empirically - as a core element of social sustainability;
- Important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- The challenges of trade-offs between the different goals of sustainable development;
- The respective impacts on individual and societal decision-making.

The course is structured as follows:
- Overview of concepts and methods of inter-transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Practical application of the methods in a broader project setting (approx. 30%)
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

This course is recommended for students participating in the Transdisciplinary Case Study 2016.

Objective

At the end of the course, students should:

Know:
- Function, purpose and algorithm of a selected number of multivariate methods
- Analysis of a selected number of multivariate methods focusing on model specification and diagnostics of the various models

Understand:
- Multivariate methods

Be able to reflect on:
- Potential, limits, and necessity of multivariate methods

Be prepared for:
- Multivariate Methods 2016

The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.

The course will begin with an introduction to multivariate methods such as analysis of variance and multiple linear regression, where a metric dependent variable is "explained" by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.
Introduction to Cultural Ecology

Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design policy examples. E-version is partly available under link.

This lecture introduces to the basic principles of cultural ecology in a historical and cross-cultural perspective. It presents the most important scientific theories and methods in cultural studies and relates them to selected case studies relevant to environment and ecology. Human and social environment interactions are analysed in various European and Non-European settings.

Objective

The objective of this lecture is to demonstrate the cultural foundations of ecological phenomena and the use and management of nature and natural resources as responses of man and society towards their environment. An introspection into the rationale of cultural processes of nature appropriation shall enable students to understand human and social development processes throughout the history of culture and mind.

The objective of this lecture is to demonstrate the cultural foundations of ecological phenomena and the use and management of nature and natural resources as responses of man and society towards their environment. An introspection into the rationale of cultural processes of nature appropriation shall enable students to understand human and social development processes throughout the history of culture and mind.

Major in Environmental Systems Policy

Theoretical Foundations for Environmental Policy

Number Title Type ECTS Hours Lecturers
701-1553-00L Introduction to Cultural Ecology W 3 credits 2G K. T. Seeland

Abstract

This lecture introduces to the basic principles of cultural ecology in a historical and cross-cultural perspective. It presents the most important scientific theories and methods in cultural studies and relates them to selected case studies relevant to environment and ecology. Human and social environment interactions are analysed in various European and Non-European settings.

Objective

The objective of this lecture is to demonstrate the cultural foundations of ecological phenomena and the use and management of nature and natural resources as responses of man and society towards their environment. An introspection into the rationale of cultural processes of nature appropriation shall enable students to understand human and social development processes throughout the history of culture and mind.

Prerequisites / notice

We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

Content

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of 'environmental governance' and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Lecture notes

Lecture notes will mostly work with readings from the following books:


Literature

A detailed course schedule will be made available at the beginning of the semester.

Prerequisites / notice

We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

Number Title Type ECTS Hours Lecturers
701-1553-00L Introduction to Cultural Ecology W 3 credits 2G K. T. Seeland

Abstract

This lecture introduces to the basic principles of cultural ecology in a historical and cross-cultural perspective. It presents the most important scientific theories and methods in cultural studies and relates them to selected case studies relevant to environment and ecology. Human and social environment interactions are analysed in various European and Non-European settings.

Objective

The objective of this lecture is to demonstrate the cultural foundations of ecological phenomena and the use and management of nature and natural resources as responses of man and society towards their environment. An introspection into the rationale of cultural processes of nature appropriation shall enable students to understand human and social development processes throughout the history of culture and mind.

851-0589-00L Technology and Innovation for Development

Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects..

Objective

- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

Content

Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies. The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Lecture notes

Reader with issue-specific articles. E-version is partly available under link.

http://www.ib.ethz.ch/teaching/material/stpp
The objectives of this course are to develop the following key skills necessary for policy analysts:

- Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid.

**Type**

- Multivariate Methods

**Lecturers**

- I. Günther

**Prerequisites / notice**

The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester. The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

**851-0626-01L International Aid and Development**

**Prerequisites:** Basic knowledge of economics

**Abstract**

The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.

**Objective**

Students are able to critically discuss the various aid instruments of bi-and multilateral donors and NGOs.

**Content**

Introduction to the Determinants of Underdevelopment; History of Aid; Aid and Development: Theories and Empirics; Political Economy of Aid; Experience and Impact of Aid; New Instruments of Aid: e.g. Micro-Finance, Budget-Support; Fair-Trade.

**Literature**

Articles and book abstracts will be uploaded to a course website.

### Modeling and Statistical Analysis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1561-00L</td>
<td>Modeling Environmental Policy Problems</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Patt, T. Schmidt, E. Trutnevyte, O. van Vliet</td>
</tr>
<tr>
<td>701-1541-00L</td>
<td>Multivariate Methods</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>R. Hansmann</td>
</tr>
</tbody>
</table>

**Number**

- 701-1561-00L: Modeling Environmental Policy Problems
- 701-1541-00L: Multivariate Methods

**Abstract**

- The lectures introduce students to the principles of quantitative policy analysis, namely the methods to predict and evaluate the social, economic, and environmental effects of alternative strategies to achieve public objectives. A series of graded assignments will give students an opportunity for students to apply those methods to a set of case studies.

**Objective**

- Identifying the critical quantitative factors that are of importance to policy makers in a range of decision-making situations.
- Developing conceptual models of the types of processes and relationships governing these quantitative factors, including stock-flow dynamics, feedback loops, optimization, sources and effects of uncertainty, and agent coordination problems.
- Develop and program numerical models to simulate the processes and relationships, in order to identify policy problems and the effects of policy interventions.
- Communicate the findings from these simulations and associated analysis in a manner that makes transparent their theoretical foundation, the level and sources of uncertainty, and ultimately their applicability to the policy problem.

**Content**

The course will proceed through a series of policy analysis and modeling exercises, involving real-world or hypothetical problems. The specific examples around which work will be done will concern the environment, energy, health, and natural hazards management.

**Literature**


Diamond, Jared. 2012. 'The World Until Yesterday; What Can We Learn from Traditional Societies?' New York: Viking.


### Modeling and Statistical Analysis

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<td>2V+1U</td>
<td>R. Hansmann</td>
</tr>
</tbody>
</table>

**Number**

- 701-1561-00L: Modeling Environmental Policy Problems
- 701-1541-00L: Multivariate Methods

**Abstract**

- The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.

**Objective**

- Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid.

**Content**

- Identifying the critical quantitative factors that are of importance to policy makers in a range of decision-making situations.
- Developing conceptual models of the types of processes and relationships governing these quantitative factors, including stock-flow dynamics, feedback loops, optimization, sources and effects of uncertainty, and agent coordination problems.
- Develop and program numerical models to simulate the processes and relationships, in order to identify policy problems and the effects of policy interventions.
- Communicate the findings from these simulations and associated analysis in a manner that makes transparent their theoretical foundation, the level and sources of uncertainty, and ultimately their applicability to the policy problem.

**Literature**


Diamond, Jared. 2012. 'The World Until Yesterday; What Can We Learn from Traditional Societies?' New York: Viking.


GIS - Introduction into Geoinformation Science and Technology

Number of participants limited to 80.

Abstract
Theoretical basics and fundamental concepts of Geographic Information Science (GIS) are imparted and subsequently further elaborated with the software ArcGIS.
At the end, the students will be able to independently solve basic realistic GIS problems.

Objective
Students are able to
- elucidate the theoretical and conceptional foundations of geographic information systems (GIS)
- independently perform normal GIS work using commercial software and practical examples

Content
The course covers the following topics:
- What is GIS? What are spatial data?
- The representation of reality by means of spatial data models: vector, raster, TIN
- The four phases of data modelling: Spatial, conceptual, logical and physical model
- Basic concepts of database management systems and spatial databases
- Possibilities of data collection
- Transition of reference frame
- Spatial Analysis I: query and manipulation of vector data
- Spatial Analysis II: operators and functions with raster data
- Digital elevation models and derived products
- Process modelling with vector and raster data
- Presentation possibilities of spatial data

Literature
One Friday is reserved for a field trip or guest speaker;


Prerequisites / notice
Aufgrund der Grösse des verfügbaren EDV-Schulungsraumes ist die Teilnehmerzahl auf 80 Studierende beschränkt! Für die Übungen werden die Studierenden auf verschiedene Zeitenstufen aufgeteilt. Pro Zeitenstufen können maximal 20 Studierende betreut werden.
The lectures will introduce students to the principles of quantitative policy analysis, namely the methods to predict and evaluate the social, economic, and environmental effects of alternative strategies to achieve public objectives. A series of graded assignments will give students an opportunity for students to apply those methods to a set of case studies.

**PART 1** introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

**PART 2** discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

**PART 3**, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

### Content

**Policy Engagement**

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<tr>
<td>2G</td>
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<td>8G</td>
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**701-0967-00L Project Development in Renewable Energies**

**Abstract**

Project development in renewable Energies. Realization of projects in the field of renewable energies, analysis of frame conditions and risks. The students learn basics of renewable energy project realization from acknowledged experts active in the field. They identify the different tasks of various investor types. They develop sample projects in practice within groups.

**Objective**

You become acquainted with the regulative, juridical and economic requirements of project development in renewable energies. You learn to launch and judge projects by exercises in groups. You recognize chances and risks of renewable energy projects.

**Content**

Business models for renewable energy projects. Introduction of market trends, market structure, technical trends and regulation in Switzerland and in the EU internal energy market. Necessary frame conditions for profitable projects. Project development samples and exercises in wind power, hydro power, photovoltaics, due diligence and country assessment.

**Lecture notes**

PPT presentation will be distributed (in German) special frames: [http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html](http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html)

**Literature**


Mit einer grünen Anlage schwarze Zahlen schreiben [http://www.rechsteiner-basel.ch/uploads/media/Mit_einer_gruenen_Anlage_schwarze_Zahlen_schreiben.pdf](http://www.rechsteiner-basel.ch/uploads/media/Mit_einer_gruenen_Anlage_schwarze_Zahlen_schreiben.pdf)


[http://emp.lbl.gov/sites/all/files/lbnl-6356e.pdf](http://emp.lbl.gov/sites/all/files/lbnl-6356e.pdf)


**701-1543-00L Transdisciplinary Methods and Applications**

**Prerequisites / notice**

For group exercise and presentation reasons the number of participants is limited to 30 students. For exercises students build learning and presentational groups.
Abstract
The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

Objective
At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2016

Content
The lecture is structured as follows:

- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Lecture notes
Handouts are provided by the lecturers

Literature
Selected scientific articles and book-chapters

Prerequisites / notice
This course is recommended for students participating in the Transdisciplinary Case Study 2016.

Sustainability Assessment

Abstract
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

Objective
At the end of the course students should

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content
The course is structured as follows:

- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

Environmental Regulation: Law and Policy

Number of participants limited to 15.
Particularly suitable for students of D-USYS

Abstract
The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

Objective
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Content
Topics covered in lectures:

(1) Environmental Regulation
- Perspectives
- Regulatory Challenges of Environment Problems
- Regulatory Tools
(2) Law: International, European and national laws
- International law
- European law
- National law
(3) Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
- Policy brief - a maximum of 2 pages (including graphs and tables);
- Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
- Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.
Lecture notes

The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0577-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

**Major in Forest and Landscape Management**

**Natural Science Foundations**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1613-01L</td>
<td>Advanced Landscape Research</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>M. Bürgi, J. Bolliger, U. Gimmi, M. Hunziker</td>
</tr>
</tbody>
</table>

**Abstract**

This course introduces landscapes as socially perceived, spatially and temporally dynamic entities that are shaped by natural and societal factors. Concepts and qualitative and quantitative methods to study landscapes from an ecological, societal and historical perspective are presented. In a term paper students work on a landscape-related topic of their choice.

**Objective**

Students will:
- learn about concepts and methods to quantify structural and functional connectivity in landscapes, particularly
- be introduced to the topic of landscape genetics and its benefits and (current) limitations for applied conservation
- learn about concepts and methods in scenario-based land-use change modelling
- approach an understanding of landscape as perceived environment
- learn about concepts of landscape preference and related measurement methods
- understand the role of landscape for human well-being
- be introduced into approaches of actively influencing attitudes and behavior as well as related scientific evaluation
- make use of various historical sources to study landscapes and their dynamics
- interpret landscapes as a result of ecological constraints and anthropogenic activities.

**Content**

1. Encompassing concepts and approaches
   - European Landscape Convention (ELC)
   - Ecosystem Services (ES): introduction and critical evaluation

   Thematic topics
   2. Ecological approach:
      - green infrastructure (e.g., ecological conservation areas)
      - landscape connectivity
      - landscape genetics and management applications
      - concepts of specific quantitative methods: least cost paths, resistance surfaces, Circuitscape, networks (Conefor), land-use change models, various statistical methods

   3. Social-science approach:
      - principle of landscape as perceived and connoted environment
      - theories on landscape preference and place identity
      - role of landscapes for recreation, health and well-being
      - intervention approaches for influencing attitudes and related behavior
      - methods of investigating the human-landscape relationship and evaluating interventions

   4. Historical approach:
      - land use history of Switzerland (agricultural history, forest and woodland history)
      - historical legacies of land use in landscapes and ecosystems
      - historic-ecological approaches and applications

   5. Land change science:
      - modelling future land-use (CLUE, other scenario-based models)
      - landscape functions and services

   Lecture notes
   Handouts will be available in the course and for download

**701-1615-00L Advanced Forest Pathology**

**Abstract**

In-depth understanding of concepts, insight into current research and experience with methods of Forest Pathology based on selected pathosystems.

**Objective**

To know current biological and ecological research on selected diseases, to be able to comment on it and to understand the methods.

To understand the dynamics of selected pathosystems and disturbance processes.

To be able to diagnose tree diseases and injuries.

To know forest protection strategies and to be able to comment on them.

**Content**

Stress and disease, virulence and resistance, disease diagnosis and damage assessment, tree disease epidemiology, disease management, ecosystem pathology.

Systems (examples): Air pollution and trees, endophytic fungi, mycorrhiza, wood decay, conifer- root rot, Phytophthora diseases, chestnut canker and its hypoviruses, urban trees, complex diseases, emerging diseases

**Lecture notes**

no script, the ppt-presentations and specific articles will be made available among others:


The course is composed of introductory lectures, practical work, discussions and reading. The participants should have basic knowledge in forest pathology (corresponding to the course 701-0563-00 "Wald- und Baumkrankheiten, see teaching book of H. Butin: Tree diseases and disorders, Oxford University Press 1995. 252 pp.").

701-1644-00L Mountain Forest Hydrology

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<tr>
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<tr>
<td>701-1644-00L</td>
<td>Mountain Forest Hydrology</td>
<td>W</td>
<td>5 credits</td>
<td>3G</td>
<td>J. W. Kirchner</td>
</tr>
</tbody>
</table>

Abstract

This course presents a process-based view of the hydrology, biogeochemistry, and geomorphology of mountain streams. Students learn how to integrate process knowledge, data, and models to understand how landscapes regulate the fluxes of water, sediment, nutrients, and pollutants in streams, and to anticipate how streams will respond to changes in land use, atmospheric deposition, and climate. Students will have a broad understanding of the hydrological, biogeochemical and geomorphological functioning of mountain catchments. Streams are integrated monitors of the health and functioning of their surrounding landscapes. Streams integrate the fluxes of water, solutes, and sediment from their contributing catchment area; thus they reflect the spatially integrated hydrological, ecophysiological, biogeochemical, and geomorphological processes in the surrounding landscape. At a practical level, there is a significant public interest in managing forested upland landscapes to provide a reliable supply of high-quality surface water and to minimize the risk of catastrophic flooding and debris flows, but the scientific background for such management advice is still evolving.

Using a combination of lectures, field exercises, and data analysis, we explore the processes controlling the delivery of water, solutes, and sediment to streams, and how these processes are affected by changes in land cover, land use, and climate. We review the connections between process understanding and predictive modeling in these complex environmental systems. How well can we understand the processes controlling watershed-scale phenomena and what uncertainties are unavoidable? What are the relative advantages of top-down versus bottom-up approaches? How much can "black box" analyses reveal about what is happening inside the black box?

Conversely, can small-scale, micro-mechanistic approaches be successfully "scaled up" to predict whole-watershed behavior? Practical problems to be considered include the effects of land use, atmospheric deposition, and climate on streamflow, water quality, and sediment dynamics, illustrated with data from experimental watersheds in North America, Scandinavia, and Europe.

Lecture notes

No Script

Literature

Recommended and required reading will be specified at the first class session (with possible modifications as the semester proceeds).

Ecosystem Management

701-1631-00L Foundations of Ecosystem Management

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<tr>
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<tr>
<td>701-1631-00L</td>
<td>Foundations of Ecosystem Management</td>
<td>W</td>
<td>5 credits</td>
<td>3G</td>
<td>J. Ghazoul, C. Garcia</td>
</tr>
</tbody>
</table>

Abstract

This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

Objective

Students should be able to:

a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.

b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

Content

Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional markets will have frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Lecture notes

No Script

Literature


This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance. The learning concept is based on the co-ordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning.

The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the complex environmental legal system and their application in concrete cases. The students are able to formulate typical legal questions, to understand the argumentation of courts and to solve simple legal problems with respect to environmental problems.

We will mostly work with readings from the following books:

- "Evolution and natural resource governance: Making it work" by N. Dajcar
- "Environmental Governance: The Challenge of Legitimacy and Effectiveness" by K. Högler, K. Vardan, E. Nordbeck, M. Pregernig
- "Environmental governance" by J. P. Evans
- "The politics of the environment: Ideas, activism, policy (2nd ed.)" by N. Carter
- "Keil/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3
- "Griffel, A.: Raumplanungs- und Baurecht in a nutshell, Dike Verlag, Zürich/St. Gallen 2012
- "Rausch-Martti/Giffel; Umweltrecht Ein Lehrbuch, Herausgeber: Walter Haller, Schulthess Verlag, Zürich 2004
- "Rausch, H.; Panorama des Umweltrechts - Kompendium der Umweltschutzvorschriften des Bundes, BUWAL-Schriftenreihe Umwelt Nr. 226, 4. A., Bern 2005
- "Keil/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3
- "Umweltrecht in der Praxis URP (Juristische Fachzeitschrift für Umweltrechtfragen, herausgegeben von der Vereinigung für Umweltrecht (VUR)
- "Weitere Literaturangaben erfolgen in der ersten Veranstaltung.

- Waldrecht - Natur- und Landschaftsschutzrecht
- Wasserrecht - Raumplanungsrecht - Umweltschutzrecht - Verfahrensrecht

Unterrichtsprache: Deutsch

Lecture notes

Weitere Literaturangaben erfolgen in der ersten Veranstaltung.

Prerequisites / notice


701-1651-00L Environmental Governance

Abstract

The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

Objective

To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science.

To analyze the evolution as well as the key elements of environmental governance.

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

Content

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of 'environmental governance' and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Lecture notes

Lecture slides and additional course material will be provided throughout the semester.

Literature


Prerequisites / notice

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

Dat: 06.12.2018 13:04 Autumn Semester 2015 Page 1396 of 1432
### Methods and Tools

<table>
<thead>
<tr>
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<tr>
<td>701-1673-00L</td>
<td>Environmental Measurement Laboratory</td>
<td>W</td>
<td>5 credits</td>
<td>4G</td>
<td>P. U. Lehmann Grunder, D. Or</td>
</tr>
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</table>

**Abstract**
Measurements are the sole judge of scientific truth and provide access to unpredictable information, enabling the characterization and monitoring of complex terrestrial systems. Based on lectures and field- and laboratory training the students learn to apply modern methods to determine forest inventory parameters and to measure subsurface properties and processes.

**Objective**
- explain functioning of sensors that are used for characterization of landscapes and terrestrial systems
- select appropriate measurement methods and sampling design to quantify key variables and processes in the subsurface
- deploy sensors in the field and maintain sensor network
- interpret collected laboratory and field data and report main conclusions deduced from measurements

**Content**
1) Measurement Science: Measurement precision and accuracy; sensing footprint, sampling design and sampling errors, uncertainty reduction, spatial and temporal variability, sampling network design and information costs
2) Electronics: Basic introduction to electronic components, voltage and current measurements, A/D converters, power requirements, power consumption calculations, batteries, storage capacity, solar panels
3) Datalogging (Lecture): Data Logging, data transfer, storage, and sensing technologies; basic data logger programming; overview of soil sensor types and sensor calibration; including programming in the laboratory
4) Geophysical methods on Subsurface Characterization: Basic principles of ERT, GPR, and EM;
5) Soil and Groundwater Direct Sampling (Lab): Soil physical sampling; profile characterization, disturbed and undisturbed soil sampling, direct-push geoprobe sampling; soil water content profiles and transects;
6) Electronics Laboratory: Setup and measurement of simple circuits, selection and use of voltage dividers, batteries and solar panels; pressure and temperature measurements;
7) Deployment of monitoring network: Field installation of TDR, temperature probes, tensiometers, data loggers and power supply
8) Geophysics lab: Demonstration and application of geophysical methods in the field;
9 & 10) Forest characterization/ inventory: Principles of LIDAR; structures and features of the tree crowns, size/volume of the leaf area tree positions and diameters at breast height
11 & 12) Ecological and Soil Monitoring Networks- Data management for long term monitoring networks Tereno, and other critical zone observatories
13) Remote Sensing- Basic principles and forest-related examples including data extraction and analysis

**Lecture notes**
Lecture material on page:
http://www.step.ethz.ch/education/active-courses/environmental-measurements-laboratory

**Literature**
Lecture material on page:
http://www.step.ethz.ch/education/active-courses/environmental-measurements-laboratory

**Prerequisites / notice**
The details of the schedule will be optimized based on the number of students; some blocks of the course will be offered as well to students of Environmental Engineering

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### Electives

#### Ecosystem Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1453-00L</td>
<td>Ecological Assessment and Evaluation</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
<td>F. Knaus, U. Bollens Hunziker</td>
</tr>
</tbody>
</table>

**Abstract**
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

**Objective**
Students will be able to:
1) critically consider biological data books and local, regional, and national inventories;
2) evaluate the validity of ecological criteria used in decision making processes;
3) critically appraise the handling of ecological data and criteria used in the process of evaluation
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

**Lecture notes**
Basic literature and references are listed on the webpage.

**Prerequisites / notice**
The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group. Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbioökologie

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>701-1661-00L</td>
<td>Conservation and Development in Complex</td>
<td>W</td>
<td>3 credits</td>
<td>6G</td>
<td>C. Garcia, J. Ghazoul</td>
</tr>
</tbody>
</table>
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Day 1: Ecology of the forest habitats
A first impression of the biology of the region will be gained through an exploration of the different forest formations, ranging from mesic to dry evergreen, dry deciduous, and mangrove forests. The learning objective will be to understand the underlying environmental conditions that determine forest formations within the relatively small area of Shipstern Reserve. This includes linking climate, soil, and geology with community processes to understand the mosaic of habitat types, their distribution, form, and function.

Day 2: The ecology of natural resources
Students will begin to explore how people use forest resources, ranging from timber, to a variety of non-timber forest products, and animals for hunting. This will lead to an evaluation of threats to species and habitats, and hence set the scene for subsequent work.

Day 3: Familiarisation with landscape scale dynamics
We will explore the land uses in the landscape in the vicinity of Shipstern and Freshwater creeks. This will encompass a range of land uses, including small scale to large scale agriculture, extractive forest reserves, and protected forests. In the process the students will gain a better understanding of the pressures on land and forests, and a chance to meet some of the local stakeholders involved in land use transformations.

Days 4 & 5: Problem conceptualisation
Working with reserve managers and local stakeholders the students will develop a conceptual understanding of the key problems in the region, including the underlying drivers of change.

Days 6-9: Integrative analysis
Students, working in small groups, will analyse selected natural resource problems in greater depth. Options include biodiversity responses to habitat fragmentation, conservation management of mangrove and coral reef systems, restoration ecology, community forest management, and tourism development, among others. Students will have opportunities to collect original data across natural and social sciences, and will use different modelling approaches to explore future development trajectories.

Day 10-11: Synthesis and presentation of results
Research will be synthesised and presented to the local management community of Shipstern and Freshwater Creek reserves. The course will conclude with an afternoon allocated to discussion and debriefing, including an appraisal of the challenges of addressing natural resource management issues in complex socioecological systems, and the lessons learned.

Prerequisites / notice
Foundations of Ecosystem Management

Decision Making, Policy and Planning

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<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>851-0735-11L</td>
<td>Environmental Regulation: Law and Policy</td>
<td>W</td>
<td>3 credits</td>
<td>1S</td>
<td>J. van Zeben</td>
</tr>
</tbody>
</table>

The course is fully booked.

Abstract
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Objective
Topics covered in lectures:

1. Environmental Regulation
   a. Perspectives
   b. Regulatory Challenges of Environment Problems
   c. Regulatory Tools
2. Law: International, European and national laws
   a. International law
   b. European law
   c. National law
3. Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

Methods and Tools

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1671-00L</td>
<td>Sampling Techniques for Forest Inventories</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>D. Mandallaz</td>
</tr>
</tbody>
</table>
Abstract
Introduction to design and model assisted sampling theory for finite populations as well as to the infinite population model for forest inventory. Two-phase two-stage forest inventories with simple or cluster sampling. Small area estimation. Presentation of the Swiss National Inventory.

Objective
Students should have a good understanding of the concepts of general sampling theory in a modern framework. They should also master the specific problems arising in forest inventory and be able, if necessary, to read more specialized books or research papers.

Content
- Model assisted procedures. Formalism of sampling theory in forest inventory. One-phase simple and cluster sampling schemes.

Lecture notes
Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants.

Literature
Sampling methods, remote sensing and GIS multisource forest inventory M. Kohl, S. Magnussen, M. Marchetti, 2006, Springer.
Sampling techniques for forest inventories, Daniel Mandallaz, 2007, Chapman and Hall.

Prerequisites / notice
A simulation software will be used throughout the lectures to illustrate the theoretical developments. Upon request a half day field demonstration can be organized at the WSL outside the lecture time. A rettornium for the exam is also offered.

701-1682-00L Dendroecology W 3 credits 3G C. Bigler, D. Frank, A. Rigling

Abstract
The course dendroecology offers theoretical and practical aspects of dendrochronology. The impact of different environmental influences on tree-ring characteristics will be shown. The students learn various methods to date tree rings and they understand how ecological and environmental processes and patterns can be reconstructed using tree rings.

Objective
The students...
- understand, how wood is configured and how tree-ring structures are formed.
- are able to identify and describe different tree-ring structures.
- understand the theoretical and practical aspects of the dating of tree rings.
- know the effects of different abiotic and biotic environmental influences (climate, site, competition, insects, fire, physical-mechanical influences) on trees and tree rings.
- discover a tool for understanding and reconstructing global change processes.
- learn software to date, standardize and analyze tree rings.
- get hands-on experience based on the demonstration of wood (increment cores, stem discs, wedges), sampling in the field, and measuring and dating of tree rings in the tree-ring lab.
- solve R-based exercises (R tutorial will be provided) and answer questions in Moodle.
- work out an independent research question related to a dendroecological topic and write a short literature review based on scientific papers.

Content
- Overview and history of dendrochronology
- Principles of dendrochronology
- Evolution of tree rings
- Formation and structure of wood and tree rings
- Intra-seasonal tree-ring growth
- Continuous and discontinuous tree-ring characteristics
- Sampling and measuring
- Crossdating methods (visual, skeleton plots, quantitative)
- Standardization of tree-ring series
- Development of tree-ring chronologies
- Dendroecology, dendrohydrology, dendroglaciology
- Stable isotopes
- Climate, climate-growth relationships, climate reconstructions
- Age and size structures, forest dynamics (regeneration, growth, competition, mortality)
- Disturbance ecology (fire, insects, blowdown)
- Application of tree-ring research in practice and in interdisciplinary research projects
- Field and lab day (date for one entire day or two half days will be searched together with the students in the beginning of the semester): discussion of different dendroecological questions in the forest; sampling of trees; insight into different tree-ring projects in the lab (Swiss Federal Institute for Forest, Snow and Landscape Research WSL).

Lecture notes
The lecture notes (in English) will be handed out in the class.

Literature
The lecture notes and further documents (papers, software) can also be downloaded from Moodle (https://moodle-app2.let.ethz.ch) following registration for the course.

Prerequisites / notice
Time schedule (total of 90 hours): There will be 12 lectures with each two hours (total of 24 hours presence) as well as a field and lab day (8 hours presence). In addition, the students are expected to put 18 hours into the preparation of the lectures as well as 18 hours for the exercises. 4 hours are reserved for the lab work and 18 hours for the project.

The class language is German and English, on request English only.

Requirements:
Basics of biology, ecology and forest ecology

701-1776-00L Geographic Data Processing with Python and ArcGIS W 1 credit 2U A. Baltensweiler

Abstract
The course gives a general introduction into the geoprocessing framework of ArcGIS and shows how to use python scripts to access and automate geoprocessing tasks. Furthermore, the basics of the programming language Python will be communicated which is required for the implementation of multilevel spatial analysis and dynamic models.

Objective
The students learn the basics of geographic data processing based on the programming language Python and ArcGIS (arcpy). They get the ability to implement their own processing sequences and models for geoprocessing.

Content
The course communicates a deep understanding of geoprocessing frameworks arcpy and covers basic language concepts of Python e.g. like control structures, functions and sequences.

Lecture notes
The lecture notes, exercises and worked out solutions to them will be provided.

Literature

Prerequisites / notice
The course will be taught in German. All material will be provided in English. Knowledge of ArcGIS is assumed.
At the end of this module students are able:

- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Content

- Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Lecture notes

Handouts are provided to students in the classroom.

Prerequisites / notice

Language of the course is English.

401-0627-00L 4 credits 2G S. Beran-Ghosh

1. Smoothing and Nonparametric Regression with Examples

Abstract

Starting with an overview of selected results from parametric inference, kernel smoothing (including local polynomials) will be introduced along with some asymptotic theory, optimal bandwidth selection, data driven algorithms and some special topics. Examples from environmental research will be used for motivation, but the methods will also be applicable elsewhere.

Objective

The students will learn about methods of kernel smoothing and application of concepts to data. The aim will be to build sufficient interest in the topic and intuition as well as the ability to implement the methods to various different datasets.

Content

- Parametric estimation methods: selection of important results
  - Maximum likelihood
- Least squares: regression & diagnostics
- Nonparametric curve estimation
  - Density estimation, Kernel regression, Local polynomials, Bandwidth selection
- Selection of special topics (as time permits, we will cover as many topics as possible) such as change points, modes & monotonicity, robustness, partial linear models, roughness penalty, local likelihoods, etc.
- Applications: potential areas of applications will be discussed such as, change assessment, trend and surface estimation, probability and quantile curve estimation, and others.

Lecture notes

Brief summaries or outlines of some of the lecture material will be posted at http://www.wsl.ch/info/mitarbeitende/ghosh/index_EN (click on "ETH Course" in the left panel).

NOTE: The posted notes will tend to be just sketches whereas only the in-class lessons will contain complete information.

LOG IN: In order to have access to the posted notes, you will need the course user id & the password. These will be given out on the first day of the lectures.

Literature

References:

- Statistical Inference, by S.D. Silvey, Chapman & Hall.
- Density Estimation, by B.W. Silverman, Chapman and Hall.
- Kernel Smoothing, by M.P. Wand and M.C. Jones, Chapman and Hall.
- Nonparametric Simple Regression, by J. Fox, Sage Publications.

Additional references will be given out in the lectures.

Prerequisites / notice

Prerequisites: A background in Linear Algebra, Calculus, Probability & Statistical Inference including Estimation and Testing.

Colloquium

Colloquium Forest and Landscape Management

Number

701-1691-00L

Title

Colloquium with Topics on Forest and Landscape Management

Abstract

Austausch-Plattform zwischen Forschung und Praxis im Waldbereich der Schweiz (in German)

ECTS

0 credits

Hours

1.5K

Lecturers

H. R. Heinimann

Public Health

Epidemiology and Prevention

Number

752-6105-00L

Title

Epidemiology and Prevention

Abstract

The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Objective

Students are able:

- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

Content

The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

Public Health Concepts

Number

752-6151-00L

Title

Public Health Concepts

Abstract

The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

Objective

At the end of this module students are able:

- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Content

Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Applied Biostatistics

Number

401-0629-00L

Title

Applied Biostatistics

Abstract

Handouts are provided to students in the classroom.

Prerequisites / notice

Language of the course is English.
Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student will choose some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

This course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, and adaptive immunity). The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. Key experimental results will be shown to help understanding how immunological textbook knowledge has evolved.

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods. The students are expected to do hands-on experiments and to engage in discussions about the underlying mechanisms. The course will cover six grand topics in molecular biology and genetics (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, and adaptive immunity).

The course provides a detailed understanding of - development of T and B cells - the dynamics of an immune response during acute and chronic infection - mechanisms of immunopathology - modern vaccination strategies

Key experimental results will be shown to help understanding how immunological textbook knowledge has evolved.

The course will cover six grand topics in molecular biology and genetics (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, and adaptive immunity).

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The course provides a detailed understanding of - development of T and B cells - the dynamics of an immune response during acute and chronic infection - mechanisms of immunopathology - modern vaccination strategies

Key experimental results will be shown to help understanding how immunological textbook knowledge has evolved.

Prerequisites / notice

The statistical package R will be used in the exercises. If you are unfamiliar with R, I highly recommend the online R course etutoR.

Infectious Diseases

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0263-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious Diseases</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
</tr>
<tr>
<td>551-0223-00L</td>
<td>Immunology III</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Kopf, M. Bachmann, J. Kisielov, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Sörri</td>
</tr>
<tr>
<td>551-1171-00L</td>
<td>Immunology: from Milestones to Current Topics</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>B. Ludewig, M. Kopf, A. Oxenius, University lecturers</td>
</tr>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Loesner, M. Schuppler</td>
</tr>
</tbody>
</table>

Abstract

Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.

Objective

Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the results.

Content


Lecture notes

see teaching document repository

Literature


### Nutrition and Health

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann, V. Visschers</td>
</tr>
</tbody>
</table>

**Abstract**
This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

**Objective**
The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
</tbody>
</table>

**Abstract**
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

**Objective**
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

**Content**
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

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<tr>
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</thead>
<tbody>
<tr>
<td>752-6101-00L</td>
<td>Nutrition and Chronic Disease (HS)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
</tr>
</tbody>
</table>

**Abstract**
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes**
There is no script. Powerpoint presentations will be made available on-line to students.

**Literature**
To be provided by the individual lecturers, at their discretion.

**Prerequisites / notice**
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

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</tr>
</thead>
<tbody>
<tr>
<td>752-6402-00L</td>
<td>Nutrigenomics - toward personalized nutrition?</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>G. Vergères</td>
</tr>
</tbody>
</table>

**Abstract**
Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genomics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

**Objective**
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understanding of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics.
- For the content of the script see section "Skript" below

**Content**
The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.
The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
Nutritional genomics

Module C
Nutrigenetics

Module D
Nutri-epigenomics

Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualized nutrition - opportunities and challenges

No extra reading requested. Most slides in the lecture are referenced with web addresses.

Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

### Environment and Health

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
</tbody>
</table>

**Abstract**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

**Objective**
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

**Content**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

**Lecture notes**
Handouts will be distributed

**Literature**
Will be mentioned in handouts

### Term Paper

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.

**Objective**
- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising of academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

**Content**
Topics are offered in the domains of the major 'Human Health, Nutrition and Environment' covering 'Public Health', 'Infectious Diseases', 'Nutrition and Health' and 'Environment and Health'.

**Lecture notes**
Guidelines will be handed out in the beginning.

**Literature**
Literature will be identified based on the topic chosen.

### Minors

#### Minor in Sustainable Energy Use

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0967-00L</td>
<td>Project Development in Renewable Energies Number of participants limited to 30.</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>R. Reochsteiner, A. Appenzeller, A. Wanner</td>
</tr>
</tbody>
</table>

**Abstract**
Project development in renewable Energies

Realization of projects in the field of renewable energies, analysis of frame conditions and risks. The students learn basics of renewable energy project realization from acknowledged experts active in the field. They identify the different tasks of various investor types. They develop sample projects in practice within groups

**Objective**
You become acquainted with the regulative, juridical and economic requirements of project development in renewable energies.

You learn to launch and judge projects by exercises in groups

You recognize chances and risks of renewable energy projects
Will be identified based on the chosen topic.

Energy- and Climate Systems I

The Slides from the lecture serve as lecture notes and are available as download.

From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the

Carbon Mitigation

The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will
discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory
lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

Objective

The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their
potential, their cost, and their consequences.

Content

From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the
students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole
group.

Lecture notes

None

Literature

Will be identified based on the chosen topic.

Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

051-0551-00L Energy- and Climate Systems I

The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and
climatisation of buildings and their interaction with architecture and urban design. Using calculations, students learn to aquire relevant
numbers and assess the performance of solutions.

Objective

The lecture's target is the knowledge of the physical basics and technical components of relevant systems for an efficient and sustainable
climatisation and maintenance of buildings and their interdependency with the architectonic design and construction. By learning rough
calculation methods, determination of relevant dimensions and identification of important parameters become possible. Hence, adequate
approaches for the own design can be chosen, reviewed quantitatively and qualitatively and set in with a synergistic effect.

Content

1. Introduction
2. Thermal systems
3. Ventilation
4. Daylight and artificial lighting

EK I lectures focus on technical components in use as well as their rough calculation methods and their integration into design and
construction.

Lecture notes

The Slides from the lecture serve as lecture notes and are available as download.

Literature

A bibliography will be archived at the beginning of the lecture.

227-0731-00L Power Market I - Portfolio and Risk Management

Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts,
hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading,
ancillary services, balancing power market, Swiss market model, strategy development and positioning.

Objective

Knowledge on the worldwide liberalisation of electricity markets, pan-european power trading and the role of power exchanges. Understand
financial products (derivatives) based on power. Management of a portfolio containing physical production, contracts and derivatives.
Evaluate trading and hedging strategies. Apply methods and tools of risk management.
Content
1. Pan-European power market and trading
1.1. Power trading
1.2. Development of the European power markets
1.3. Energy economics
1.4. Spot and OTC trading
1.5. European energy exchange EEX

2. Market model
2.1. Market place and organisation
2.2. Balance groups / balancing energy
2.3. Ancillary services
2.4. Market for ancillary services
2.5. Cross-border trading
2.6. Capacity auctions

3. Portfolio and Risk management
3.1. Portfolio management 1 (introduction)
3.2. Forward and futures contracts
3.3. Risk management 1 (m2m, VaR, hplc, volatility, cVaR)
3.4. Risk management 2 (PaR)
3.5. Contagii valuation (HPFC)
3.6. Portfolio management 2
2.8. Risk Management 3 (enterprise wide)

4. Energy & Finance I
4.1. Options 1 basics
4.2. Options 2 hedging with options
4.3. Introduction to derivatives (swaps, cap, floor, collar)
4.4. Financial modelling of physical assets
4.5. Trading and hydro power
4.6. Incentive regulation

5. Strategy
5.1. Strategic Positioning
5.2. Development of strategies and examples
5.3. Cases for team work

Lecture notes
Handouts of the lecture

Prerequisites / notice
1 excursion per semester, 2 case studies, guest speakers for specific topics

529-0193-00L Renewable Energy Technologies I W 4 credits 3G A. Wokaun, A. Steinfeld

The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Abstract Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Objective Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.


Lecture notes Lecture notes will be distributed during the course.

Literature
- Heinloth, K.; Die Energiefrage (Vieweg, 2003)

Prerequisites / notice Fundamentals of chemistry and physics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

Minor in Global Change and Sustainability

Number Title Type ECTS Hours Lecturers
701-0015-00L Seminar on Transdisciplinary Research for Sustainable Development W 2 credits 2S C. E. Pohl, M. Stauffer
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

At the end of the course students should:

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

The course is structured as follows:

- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The workload for this course is approx. 120 hours (all inclusive).

The course is seminar-like, interactive.

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2016
Lecturers

The lecture is structured as follows:
- Overview of concepts and methods of inter/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Lecture notes
Handouts are provided by the lecturers

Literature

Selected scientific articles and book-chapters

Prerequisites / notice
This course is recommended for students participating in the Transdisciplinary Case Study 2016.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>701-1551-00L</td>
<td>Sustainability Assessment</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Krüttli, C. E. Pohl</td>
</tr>
</tbody>
</table>

Abstract
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

Objective
The course is seminar-like, interactive.

At the end of the course students should
Know:
- core concepts of sustainable development, and;
- the concept of social justice normatively and empirically as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

Minor in Life Cycle Assessment

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>102-0317-00L Advanced Environmental Assessments</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Hellweg, R. Frischknecht</td>
<td></td>
</tr>
</tbody>
</table>

Abstract
This course deepens students’ knowledge of the environmental assessment methodologies and their various applications.

Objective
This course has the aim of deepening students’ knowledge of the environmental assessment methodologies and their various applications. In particular, students completing the course should have the
- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers

Content
- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multiooutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

Lecture notes
No script. Lecture slides and literature will be made available.

Literature
Literature will be made available.

Prerequisites / notice
Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Baumann&Tillman, The Hitch Hiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications, Studentlitteratur, Lund, 2004).

102-0317-01L Advanced Environmental Assessment (Computer Lab) and Exercises | W | 3 credits | 2U+2P | S. Pfister |

Abstract
Technical systems are investigated in projects with numerical modeling. The students learn how to answer given questions with target oriented methodologies using various software programs for environmental assessment.

Objective
Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

101-0577-00L An Introduction to Sustainable Development in the Built Environment | W | 3 credits | 2G | G. Habert |

This course was offered as "Sustainable Construction" until HS14.
Abstract
This year the UN Conference in Paris will shape future world objectives to tackle climate change. This course provides an introduction to the notion of sustainable development when applied to our built environment.

Objective
At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environment aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

Content
The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

Lecture notes
Exercise notes will be provided before the lectures. For each lecture slides of the lecture will be provided.

Literature
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0041-00L</td>
<td>Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano Sinues</td>
</tr>
<tr>
<td>529-0043-00L</td>
<td>Analytical Strategy</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>R. Zenobi, M. Badertscher, P. S. Dittrich, D. Günther</td>
</tr>
<tr>
<td>701-1313-00L</td>
<td>Isotopic and Organic Tracers in Biogeochemistry</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>R. Kipfer, C. Schubert</td>
</tr>
</tbody>
</table>

Data: 06.12.2018 13:04 Autumn Semester 2015 Page 1408 of 1432
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.

Students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.

The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.

Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

The course addresses major biogeochemical processes that drive the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.

The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.

Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

The goal of this lecture is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

The large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.

Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to dispose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

This lecture course comprises of lectures with exercises and guided case studies.

- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

This is an interdisciplinary course aimed at environmental scientists and environmental engineers.
We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

To understand the fundamental physical processes in glaciology.

To learn some basic numerical modelling techniques for glacier flow.

To identify glaciological hazards and to learn some assessment and mitigation possibilities.

Basics in physical glaciology

Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges

Ice falls, ice avalanches

Glacier floods

Lake ice and bearing capacity

Handouts are available

Relevante Literatur wird während der Vorlesung angegeben.

Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Voraussetzungen: Es werden Grundkenntnisse in Mechanik und Physik vorausgesetzt.

Seminar in Glaciology

Study aktueller und klassischer Arbeiten der glaziologischen Forschung


Study aktueller und klassischer Arbeiten der glaziologischen Forschung

Handouts are available

References in script

Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes

Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff.

Processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep/rock glaciers, debris flows).

Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

http://www.uzh.ch/studies/application/mobilitaet_en.html

Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff.

Processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep/rock glaciers, debris flows).

Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

http://www.uzh.ch/studies/application/mobilitaet_en.html

Application of basic physical concepts to glaciers and ice caps. Understanding glaciers and ice sheets with simple physical concepts.

Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.

The course outlines the physical principles governing the gravity-driven motion of glacier ice. This is applied to understand the response of glaciers and ice sheets to changes in their environment. Polar ice caps, ice streams and mountain glaciers and their recent rapid changes are discussed.

The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

Good high school mathematics and physics knowledge required.

http://people.earth.ethz.ch/~luethim/teaching.html

Additionally, the module GEO817 Physische Geographie III für die Erdwissenschaften (3KP) can be taken at the UZH for this Minor. No enrolment to this course at ETH Zurich. Book the module directly at UZH (see link: http://www.vorlesungen.uzh.ch/HS15/suche/sm-50352125.modveranst.html ).
Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This

Fundamentals of Natural Hazards Management

Interception: Messung und Schätzung.

Evaporation and Evapotranspiration: Prozesse, Messung und Schätzung, potentielle und effektive Evapotranspiration, Energiebilanzmethode, empirische Methode.

Infiltration: Messung. Horton-Gleichung, empirische und konzeptionelle Methoden, F-index und Prozentuale Methode, SCS-CN Methode.


Schnee und Eis: Schneeeigenschaften und -messungen Schätzung des Schneeschmelzprozesses durch die Energiebilanzmethode, Ablusss aus Schneeschmelze, Temperatur-Index- und Grad-Tag-Verfahren.


Lecture notes

Ein internes Skript ist zur Verfügung (kostenpflichtig, nur Herstellungskosten)

Literature


Prerequisites / notice

Vorbereitende zu Hydrologie I sind die Vorlesungen in Statistik. Der Inhalt, der um ein Teil der Übungen zu behandeln und um ein Teil der Vorlesungen zu verstehen notwendig ist, kann zusammengefasst werden, wie hintereinander es beschrieben wird:


651-3525-00L

Introduction to Engineering Geology

This introductory course starts from a descriptions of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslide hazards are presented.

Objective

Understanding the basic geotechnical and geomechanical processes of rocks and soils. Understanding the interaction of rock and soil masses with technical systems. Understanding the fundamentals of geological hazards.

Content


Lecture notes

Written course documentation available under “Kursunterlagen”.

Literature


701-0565-00L

Fundamentals of Natural Hazards Management

Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.

Objective

Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:

- Risk analysis - What can happen?
  - Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
  - Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
- Risk assessment - What are the acceptable levels of risk?
  - Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
  - Explain causes for conflicts between risk perception and risk analysis.
- Risk management - What steps should be taken to manage risks?
  - Explain how various hazard mitigation approaches reduce risk.
  - Describe hazard scenarios as a base for adequate dimensioning of control measures.
  - Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
  - Explain the principles of risk-governance.

Autumn Semester 2015

Page 1411 of 1432
The general introduction shows the economic relevance of the resource wood in a global, European and Swiss context and reflects aspects of sustainability in wood production and certification. In terms of bulk wood products a specific focus is laid on sawn timber production and machining processes to fabricate targeted wood products.

Learning target is a fundamental understanding of the dominating wood machining processes, which are applied to fabricate common wood products. At the end of the lecture an excursion to a Swiss wood manufacturer is planned, in order to facilitate practical experience.

Thus, Students having already assigned to 101-0637-00 are not allowed to assign to 101-0637-10.

Abstract
The lecture Wood structure and function conveys basic knowledge on the microstructure of softwoods and hardwoods as well as general and species-specific relationships between growth processes, wood properties and wood function in the living tree.

Objective
Learning target is a basic understanding of the anatomy of wood and the resulting impact of endogenous and exogenous factors. The students can learn how to distinguish common central European wood species at the macroscopic and microscopic level. A deeper insight will be given by wood identification exercises for softwood species. Further the students will gain insights into the relationships between tree growth and wood properties with a specific focus on the wood function in the living tree.

Content
In an introduction to wood anatomy, the general structural features of softwoods and hardwoods will be explained and factors of diversity and variability will be discussed. A specific focus is laid on common central European tree species with relevance in the wood sector, which will be studied in macro- and microstructural investigations. For softwoods, exercises for the identification of species will be conducted. In the following, relationships between wood structure, properties and function in the living tree will be in the focus of the lecture. Topics covered are mechanical stability and water transport, branches, reaction wood formation (compression wood, tension wood), spiral growth and wood properties with a specific focus on the wood function in the living tree.

Students can learn how to distinguish common central European wood species at the macroscopic and microscopic level. A deeper insight will be given by wood identification exercises for softwood species. Further the students will gain insights into the relationships between tree growth processes, wood properties and wood function in the living tree.

Thus, Students having already assigned to 701-1801-00 are not allowed to assign to 101-0637-20.

Abstract
The lecture Wood processing conveys knowledge on technological properties of wood and wood-based materials as well as on industrial processes for the fabrication of a vast variety of wood products.

Objective
Learning target is a fundamental understanding of the dominating wood machining processes, which are applied to fabricate common wood products. Students will be introduced to the economic relevance of the renewable resource wood and are trained in its technological properties. The students will learn to identify the relationships between wood species and their properties as well as the suitable wood machining processes to fabricate targeted wood products.

Content
The general introduction shows the economic relevance of the resource wood in a global, European and Swiss context and reflects aspects of sustainability in wood production and certification. In terms of bulk wood products a specific focus is laid on sawn timber production and drying processes. With regard to wood veneer production, steaming, veneer cutting and assembly to veneer lumber products are presented. Further the students will get insights into the production of particle boards and fibre boards as well as paper will be discussed. In the following, the topics are related to wood gluing and wood protection as well as potentials and limitations in the application of wood and wood-based products. At the end of the lecture an excursion to a Swiss wood manufacturer is planned, in order to facilitate practical experience.

The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. S. Hellweg, R. Frischknecht.

The course deepens students' knowledge of the environmental assessment methodologies and their various applications. An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

### Environmental Management

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0317-00L</td>
<td>Advanced Environmental Assessments</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Helliweg, R. Frischknecht</td>
</tr>
<tr>
<td>102-0317-01L</td>
<td>Advanced Environmental Assessment (Computer Lab and Exercises)</td>
<td>W</td>
<td>3 credits</td>
<td>2U+2P</td>
<td>S. Pfister</td>
</tr>
</tbody>
</table>

Lecture notes: No script. Lecture slides and literature will be made available.

### Minor in Soil-Plant Relations and Land Use

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1681-00L</td>
<td>Element Balancing and Soil Functions in Managed Ecosystems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Keller</td>
</tr>
</tbody>
</table>

Lecture notes: Literature and Exercises for a case study.
Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will present the principles and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

Lecture notes
Documents will be distributed during the lecture

Prerequisites / notice
The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: www.pe.ipw.agri.ethz.ch/about/reach
Literature

Arbuscular mycorrhizas in soil nutrient management, e-learning module of Sustainable Plant Systems by Gamper, HA, van der Heijden, MGA, Hofmann, A.: https://www.olat.uzh.ch/olat/auth/1%3A1%3A0%3A0/

http://www.wiley.com/legacy/olat/auth/1%3A1%3A0%3A0%3A0/relId-a0000403.html


http://www.crcpress.com/product/isbn/9780849338557


How microbes can feed the world (American Academy of Microbiology) http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world

Can microbes feed the world? (Society for general microbiology) http://www.sgm.ac.uk/en/publications/microbiology-today/past-issues.cfm/publication/can-microbes-feed-the-world

Popular science entries to the topic:
http://www.the-scientist.com/?articles.view/articleNo/30950/title/The-Root-of-the-Problem/

Ecological Understanding (Second Edition)

Prerequisites / notice

For students of the Agricultural Sciences of D-USYS: Lectures in Plant Nutrition I and II (Nutrient cycling in agroecosystems by Prof. E. Frossard).
We ask all other course participants to read and understand the e-learning module Plant Nutrition I by Prof. E. Frossard: https://moodle-app2.let.ethz.ch/course/view.php?id=279

For students of the Agricultural Sciences of D-USYS: Lectures in Plant Nutrition I and II (Nutrient cycling in agroecosystems by Prof. E. Frossard).
We ask all other course participants to read and understand the e-learning module Plant Nutrition I by Prof. E. Frossard: https://moodle-app2.let.ethz.ch/course/view.php?id=279

This course on Rhizosphere Ecology is complementary to those on Radiotopes in Plant Nutrition, and Nutrient Fluxes in Soil-Plant Systems. However, a limited number of thematic overlaps cannot be avoided. Particular emphasis is given to the ecophysiology of interacting organisms and detection, enumeration, culturing, and molecular genetic identification of root-associated microbes. A written closed book exam will take place on Friday January 8, 2016, from 10.15-12.15am in Eschikon.

Students of the agricultural sciences of D-USYS will be reimbursed for travel expenses upon handover of collected tickets of the public transport systems, excluding the tax zone of the town of Zurich.

103-0317-00L Sustainable Spatial Development I W 3 credits 2G B. Scholl
Only for master students, otherwise a special permission by the lecturer is required.
Abstract
The lectures impart important knowledge for solving spatial relevant conflicts and problems. Case studies will be used to demonstrate the implementation in practice.

Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation. The concept of sustainable development in spatial planning leads necessarily to an efficient management of the resources, especially regarding the resource land. The basics of this important discipline will be the subject of this lecture, which is therefore organised in three parts:
- Inner development
- Integrated spatial and infrastructure development
- Cross-border issues in spatial development

### Contents

- Tasks of Spatial Planning and development
- Issues of local and supra-local interest
- Recurring spatial changes, impacts and key figures
- Formal and informal instruments and procedures in spatial planning
- Spatial Design - Ideas about the future
- Reasoning and assessing the situation in spatial planning
- Spatial planning as a sequence of decisions and interventions
- Process and procedures management
- Focus issues - Inner development before external development
- Focus issues - Cross-border tasks
- Focus Issues - Integrated spatial and infrastructure development

### Lecture notes

Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

### Number

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<tr>
<td>103-0435-01L</td>
<td>Land Management</td>
<td>W</td>
<td>5</td>
<td></td>
<td>G. Nussbaumer, F. Frei, M. Huhmann, R. Michelon</td>
</tr>
<tr>
<td>701-1695-00L</td>
<td>Soil Science Seminar</td>
<td>Z</td>
<td>0</td>
<td></td>
<td>R. Schulin</td>
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<tr>
<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W</td>
<td>2</td>
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<td>N. Buchmann, A. Lüscher</td>
</tr>
<tr>
<td>751-4101-00L</td>
<td>Crops</td>
<td>W</td>
<td>2</td>
<td></td>
<td>A. Walter, F. Liebisch, W. Richner</td>
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<tr>
<td>751-4701-00L</td>
<td>Herbology</td>
<td>W</td>
<td>2</td>
<td></td>
<td>B. Streit, N. Delabays, U. J. Haas</td>
</tr>
</tbody>
</table>

### Literature

References in the lecture notes

Download: [http://www.irl.ethz.ch/plus/education](http://www.irl.ethz.ch/plus/education)

### Minor in Agricultural Plant Production and Environment

Master and PhD students are introduced to current areas of research in soil sciences and get first-hand experience in scientific discussion.

### Number

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<tr>
<th>Number</th>
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<tr>
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<td>751-4701-00L</td>
<td>Herbology</td>
<td>W</td>
<td>2</td>
<td></td>
<td>B. Streit, N. Delabays, U. J. Haas</td>
</tr>
</tbody>
</table>

### Literature

Handouts werden auf dem Netz zur Verfügung gestellt.

Wird in der Veranstaltung angesprochen.

Course will be given in German. Course builds on the Ertrags- und Ökophysiologie lecture and provides the basics for the Grasslandsysteme.
Abstract

The focus will be on the basic principles of biology and ecology of weeds, crop-weed interactions and basic knowledge of chemical, physical and biological weed control with their respective (dis-) advantages. Furthermore students will get an introduction on the mechanisms of weed management in different farming systems and crops.

751-4003-01L

Current Topics in Grassland Sciences (HS)

W 2 credits 2S N. Buchmann

Abstract

Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

Objective

Students will be able to understand and evaluate experimental design and data interpretation of on-going studies, be able to critically analyze published research results, practice to present and discuss results in the public, and gain a broad knowledge of recent research and current topics in agro- and forest ecosystem sciences.

Content

Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

Lecture notes

none

Prerequisites / notice

Prerequisites: Basic knowledge of plant ecophysiology, terrestrial ecology and management of agro- and forest ecosystems. Course will be taught in English.

751-4104-00L

Alternative Crops

W 2 credits 2V A. Walter, B. Büter

Abstract

Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.

Objective

During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. Wikipedia-entries will be generated.

Prerequisites / notice

Students signing up for this class should have a strong interest in tropical agriculture and science communication.

751-5001-00L

Agroecologists without Borders

W 2 credits 2S C. Decock, A. Hofmann, J. Six

Abstract

In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

Objective

(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems.
(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.
(3) Students articulate complexity and challenges in agricultural development interventions.
(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.

Prerequisites / notice

Students signing up for this class should have a strong interest in tropical agriculture and science communication.

751-5003-00L

Sustainable Agroecosystems II

W 2 credits 2V J. Six, A. Hofmann

Abstract

This class is intended to convey methods of agroecological research through selected case studies from current research projects and hands-on exercises. Students will gain an overview on actors in the field of sustainable agricultural development.

Objective

(1) Get to know methods for field and laboratory investigations in agroecology, (2) Analyze case studies from current agroecological research, (3) Place institutions and related projects into the context of sustainable agricultural development

Literature


Prerequisites / notice

Prior participation in the lecture Nachhaltige Agrarökosysteme I (Sustainable Agroecosystems I) 751-5000-00G (in spring semester) recommended; classes taught mostly in English

Minor in Environmental, Resource and Food Economics

Number Title Type ECTS Hours Lecturers
363-0537-00L Resource and Environmental Economics W 3 credits 2G L. Bretschger, A. Brausmann

Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.
Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
Introduction to resource and environmental economics
Importance of resource and environmental economics
Main issues of resource and environmental economics
Normative basis
Utilitarianism
Fairness according to Rawls
Economic growth and environment
Externalities in the environmental sphere
Governmental internalisation of externalities
Private internalisation of externalities: the Coase theorem
Free rider problem and public goods
Types of public policy
Efficient level of pollution
Tax vs. permits
Command and Control Instruments
Empirical data on non-renewable natural resources
Optimal price development: the Hotelling-rule
Effects of exploration and Backstop-technology
Effects of different types of markets.
Biological growth function
Optimal depletion of renewable resources
Social inefficiency as result of over-use of open-access resources
Cost-benefit analysis and the environment
Measuring environmental benefit
Measuring costs
Concept of sustainability
Technological feasibility
Conflicts sustainability / optimality
Indicators of sustainability
Problem of climate change
Cost and benefit of climate change
Climate change as international ecological externality
International climate policy: Kyoto protocol
Implementation of the Kyoto protocol in Switzerland

Content
Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
Learning material and script can be found here: https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature
Objective

1. Knowledge of the mechanisms of agricultural trade
2. Impact of trade policy instruments on welfare and distribution
3. Specific aspects of agricultural trade and links to other courses:
   - Trade and food security
   - Trade and environment
   - Trade and development

Content

The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution. By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.

Lecture notes

Handouts (power point presentations)

Literature


Number Title Type ECTS Hours Lecturers
701-0019-00L Readings in Environmental Thinking W 3 credits 2S J. Ghazoul, C. Garcia, G. Hirsch Hadorn

Abstract

This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, and shaped its relevance to society. Above all, the course seeks to give confidence and raise enthusiasm among students to read more widely around the broad subject of environmental science and beyond.

Objective

The course will provide students with opportunities to read, discuss, evaluate and interpret key texts that have shaped the environmental movement and, more specifically, the environmental sciences. Students will gain familiarity with the foundational texts, but also understand the historical context within which their corporate and future professional work is based. More directly, the course will encourage debate and discussion of each text that is studied, from both the original context as well as the modern context. In so doing students will be forced to consider and justify the current societal relevance of their work.

Content

The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is not a scientific paper) to identify the key points for discussion. Thereafter, in each week a text (typically a chapter from a book or a paper) considered to be seminal or foundational will be assigned by a course lecturer. The lecturer will introduce the selected text with a brief background of the historical and cultural context in which it was written, with some additional biographical information about the author. He/she will also briefly explain the justification for selecting the particular text.

The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session. Presentation of the text requires the students to prepare by, for example:

- identifying the key points made within the text
- identifying issues of particular personal interest and resonance
- considering the impact of the text at the time of publication, and its importance now
- evaluating the text from the perspective of our current societal and environmental position

Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.

These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenting students will summarise the emerging points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes). In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.

Literature

The specific texts selected for discussion will vary, but examples include:
- Leopold (1949) A Sand County Almanach
- Carson (1962) Silent Spring
- Jared Diamond (1999) Collapse

Discussions might also encompass films or other forms of media and communication about nature.

701-0337-00L Environmental Mineralogy Z 1 credit 1V A. U. Gehring

Abstract

The lecture Environmental Mineralogy provides an outline of chemical and physical properties of iron oxides, clays, and carbonates. Analytical methods (XRD, spectroscopy and magnetics) are presented in order to identify and characterize minerals in natural samples as a tool for the reconstruction of weathering in soils, of diageneisis in sediment, and of phase transitions in hydrothermal systems.

Objective

Knowledge of the most important minerals (Fe-oxides, carbonates, and sheet silicates) in environmental systems
- Knowing about the technical and analytical tools for the identification and characterization of mineral phases.
- Development of strategies for the analytical handling of multiminerall systems.
- The application of mineralogical informations to solve specific environmental problems.

Content

Short introduction to mineral sciences
- Inorganic minerals and biominerals
- Analytical methods for the identification and characterization of minerals
- Weathering & diageneisis and the formation of minerals
- Minerals as environmental indicators (tropical soils and lacustrine sediments as case studies)
- The use of minerals in the environmental management (e.g. controlled landfills)
- Weathering and conservation of building materials

Lecture notes

Hand-outs are delivered

Literature


Prerequisites / notice

Voraussetzungen: Bodenchemie
## Work Experience

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-1001-00L</td>
<td>Internship ■</td>
<td>O</td>
<td>30 credits</td>
<td></td>
<td>A. Funk</td>
</tr>
</tbody>
</table>

**Abstract**

In the mandatory internship outside of ETH, the students in Environmental Sciences learn about how environmental issues are handled professionally through their own practical work and by applying the knowledge they acquired. They will analyse complex environmental problems on scientific, technical and social levels and develop solutions in conjunction with social actors.

**Objective**

The students experience political/legal, economic, social and psychological aspects in a professional working environment and acquire key skills such as communication and planning skills, cooperation with non-specialists or recognition of relevant aspects. Further they make useful contacts for starting their careers.

**Content**

This internship takes place outside of ETH. The main locations of an internship are the following: environmental consulting firms, planning and engineering offices, industrial and service companies, public administration, environmental organisations (nature conservation and protection, development cooperation).

The internship is a mandatory part of the two-year Master programme and lasts for at least 18 weeks (30 credit points). The internship agreement is a condition for the performance assessment of the internship.

The students look for a placement themselves.

**Lecture notes**

Instructions for the mandatory internship during the Master programme see www.usys.ethz.ch/en/studies/environmental-sciences/master/internship.html

**Prerequisites / notice**

Listed in the Praxisregister are Swiss companies that offer internship to students in Environmental Sciences, some explicitly offer internships in English: www.intranet.usys.ethz.ch/UMNW/berufspraxis/Praxisregister

Current employment opportunities can be found at www.intranet.usys.ethz.ch/UMNW/stellen-plattform/

To get an overview, subjects of previous internships can be found at www.intranet.usys.ethz.ch/UMNW/berufspraxis/Berufspraxisarbeiten

If publication is permitted, reports of former internships are available online as PDF-files.

Please find further information at www.usys.ethz.ch/en/studies/environmental-sciences/master/internship.html

## Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<tr>
<td>701-1002-00L</td>
<td>Master's Thesis ■</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Only students who fulfil the following criteria are allowed to begin with their Master thesis:

a) The signed request for the Bachelor's Degree Certificate has been submitted (if the Bachelor's programme has been finished at ETHZ).

b) At least 32 CP of coursework related to the major have been acquired.

c) All additional requirements (as stated in the admissions decision), including any assessment repetitions, are fulfilled.

Please submit the registration form, downloadable at www.usys.ethz.ch/docs/env/master, at the beginning of your thesis!

**Abstract**

The course is completed by a Master thesis. This component is designed to enable the students to explore how the course content can be applied to an actual scientific problem. The thesis also provides an opportunity for the students to exercise initiative and to demonstrate that they are capable of working independently and in a scientifically structured manner.

**Objective**

This component is designed to enable the students to explore how the course content can be applied to an actual scientific problem. The thesis also provides an opportunity for the students to exercise initiative and to demonstrate that they are capable of working independently and in a scientifically structured manner.

## Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
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<td>406-0062-AAL</td>
<td>Physics I ■</td>
<td>E-</td>
<td>5 credits</td>
<td>11R</td>
<td>A. Vaterlaus</td>
</tr>
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</table>

Enrolment only for MSc students who need this course as additional admission requirement.

**Abstract**

Introduction to the concepts and tools in physics: mechanics of point-like and rigid bodies, elasticity theory, elements of hydrostatics and hydrodynamics, periodic motion and mechanical waves.

**Objective**

Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter. The student should acquire an overview over the basic concepts in mechanics.

**Content**


Chapters:

1, 2, 3, 4, 5, 6 (without: 6-5, 6-6, 6-8), 7, 8 (without 8-9), 9, 10 (without 10-10), 11 (without 11-7), 13 (without 13-13, 13-14), 14 (without 14-6), 15 (without 15-3, 15-5)
Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling.

**Mathematics I**

**Objective**

Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.

**Content**

- Multivariable Differential Calculus:
  - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.
- Ordinary Differential Equations:
  - separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.
- Linear Algebra and Complex Numbers:
  - systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.

**Literature**

- utilizing high level mathematical software packages) and the interpretation of the results in the original environment.
- Friedhelm Kuypers
  Physik für Ingenieure und Naturwissenschaftler
  Band 2 Elektrizität, Optik, Wellen
  Verlag Wiley-VCH, 2003, Fr. 77.60

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**Mathematics II**

**Objective**

Continuation of the topics of **Mathematics I**. Main focus: multivariable calculus and partial differential equations.

**Content**

- Multivariable Integral Calculus:
  - functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.
- Multiple Integrals:
  - multiple integrals, line and surface integrals, work and flux, Green, Gauss and Stokes theorems, applications.
- Partial Differential Equations:
  - separation of variables, Fourier series, heat equation, wave equation, Laplace equation, Fourier transform.

**Literature**

- Thomas, G. B.: Thomas’ Calculus, Parts 1 - Early Transcendentals (Pearson Addison-Wesley).
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).
Content

1. Linear Algebra and Complex Numbers:
systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.

2. Single-Variable Calculus:
review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.

3. Ordinary Differential Equations:
separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

4. Multivariable Differential Calculus:
functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.

5. Multivariable Integral Calculus:
multiple integrals, line and surface integrals, work and flow, Green, Gauss and Stokes theorems, applications.

6. Partial Differential Equations:
separation of variables, Fourier series, heat equation, wave equation, Laplace equation, Fourier transform.

Literature

- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).
- Thomas, G. B.: Thomas' Calculus, Parts 2 (Pearson Addison-Wesley).

Abstract

Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective

The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content

From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature

- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435
  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

Abstract

General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry.

Objective

Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

Content

1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

Literature

- Lecture notes
  Nivaldo J. Tro
  Chemistry - A molecular Approach (Pearson), Chapter 1-18
- Housecroft and Constable, CHEMISTRY
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY

Abstract

Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective

The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content

From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
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Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables

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Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature

- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435
  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Basics of structure, formation and function of cells and biomacromolecules, principles of metabolism, as well as basic classical and molecular genetics and evolutionary biology.

This is a virtual self-study lecture for non-german speakers of the "Allgemeine Biology I (551-0001-00L) lecture. The exam will be written jointly with the participants of this lecture.

Objective
The understanding of some basic concepts of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its functions, as well as metabolism, inheritance and evolution.

Content
The structure and function of biomacromolecules; basics of metabolism; cell biology; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, meiosis and sexual life cycles; Mendelian and molecular genetics; animal reproduction and behavior; sensory and motor mechanisms; population biology and evolution; principles of phylogeny.

The Campbell Chapters 1-4 (10th edition) under the heading "The role of chemistry in biology" are expected. We will treat the following Campbell chapters:

| 5 | Biochemistry | Biological Macromolecules and Lipids |
| 7 | Cell biology | Cell Structure and Function |
| 8 | Cell biology | Cell Membranes |
| 10 | Cell biology | Cellular Respiration: An Introduction to Metabolism |
| 10 | Cell biology | Cellular Respiration |
| 11 | Cell biology | Photosynthesis |
| 12 | Cell Biology | Mitosis |
| 13 | The Genetic Basis of Life | Sexual Life Cycles and Meiosis |
| 14 | The Genetic Basis of Life | Mendelian Genetics |
| 15 | The Genetic Basis of Life | Linkage and Chromosomes |
| 20 | The Genetic Basis of Life | The Evolution of Genomes |
| 21 | Evolution | How Evolution Works |
| 22 | Evolution | Phylogenetic Reconstruction |
| 23 | Evolution | Microevolution |
| 24 | Evolution | Species and Speciation |
| 25 | Evolution | Macroevolution |

Lecture notes
No script

Literature

Prerequisites / notice
This is a virtual self-study lecture for non-german speakers of the "Allgemeine Biology I (551-0001-00L) lecture. The exam will be written jointly with the participants of this lecture.

Example exam questions will be discussed during the lectures, and old exam questions are kept by the various student organisations. If necessary, please contact Prof. Alexander Widmer (alex.widmer@env.ethz.ch) for details regarding the exam.

551-0002-AAL General Biology II E- 3 credits 6R U. Sauer, R. Aebersold, H.M. Fischer, W. Gruissem

701-0023-AAL Atmosphere E- 3 credits 6R H. Wernli, T. Peter

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes
Written information will be supplied.

Literature

701-0243-AAL Biology III: Essentials of Ecology E- 3 credits 6R J. Levine

Abstract
This course assigns reading for students needing further background for understanding ecological processes. Central problems in ecology, including population growth and regulation, the dynamics of species interactions, the influence of spatial structure, the controls over species invasions, and community responses to environmental change will be explored from basic and applied perspectives.
Objective

Original language Students will understand how ecological processes operate in natural communities. They will appreciate how mathematical theory, field experimentation, and observational studies combine to generate a predictive science of ecological processes.

Upon completing the course, students will be able to:

Understand the factors determining the outcome of species interactions in communities, and how this information informs management.

Apply theoretical knowledge on species interactions to predict the potential outcomes of novel species introductions.

Understanding the role of spatial structure in mediating population dynamics and persistence, species interactions, and patterns of species diversity.

Use population and community models to predict the stability of interactions between predators and prey and between different competitors.

Understand the conceptual basis of predictions concerning how ecological communities will respond to climate change.

Content

Readings from a text book will focus on understanding central processes in community ecology. Topics will include demographic and spatial structure, consumer resource interactions, food webs, competition, invasion, and the maintenance of species diversity. Each of these more conceptual topics will be discussed in concert with their applications to the conservation and management of species and communities in a changing world.

701-0401-AAL Hydrosphere E- 3 credits 6R P. Bayer, R. Kipfer

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Objective

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Content

Topics of the course.
- Physical properties of water (i.e. density and equation of state)
- Exchange at boundaries
- Ground water use
- Case studies

Literature

Textbooks for self-studying.

Surface water:
Chapter 4: Imboden, D.M., and Wüest, A. 'Mixing Mechanisms in Lakes'
Chapter 6.4: Air-Water Partitioning
Chapter 19.2: Bottleneck Boundaries

Groundwater and its dynamics
- Ground water use

Case studies
- 1. Water as resource, 2. Water and climate

Lecture notes

In addition to the self-learning literature handouts are distributed.

701-0501-AAL Pedosphere E- 3 credits 6R R. Kretzschmar

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Objective

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Content

Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Lecture notes

Lecture notes can be purchased during the first lecture (15.- SFr)


Prerequisites / notice

Prerequisites: Basic knowledge in chemistry, biology and geology.

701-0721-AAL Psychology E- 3 credits 6R M. Siegrist

Enrolment only for MSc students who need this course as additional admission requirement.
Abstract
This is an introductory course in psychology. This course will emphasize cognitive psychology and the psychological experiment.

Objective
Knowledge of key concepts and exemplary theories of psychology and their relation to "daily" psychology. Comprehension of relation between theory and experiment in psychology.

Goals: Learning how psychologists are thinking, a side change from the ETH natural science perspective to psychological thinking.

Domains of psychology:
- Psychology fields
- Concept definitions of psychology
- Theories of psychology
- Methods of psychology
- Results of psychology

Capability:
Be able to define a psychological research question
Basics understanding of role of psychology

Comprehension:
Psychology as a science of experience and behavior of the human

Content
Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des psychologischen Experiments. Themen sind u.a.: Wahrnehmung; Lernen und Entwicklung; Denken und Problemlösen; Kognitive Sozialpsychologie; Risiko und Entscheidung.

Literature
English book of Zimbardo (http://www.amazon.de/Psychology-Life-Discovering-Psych-Lab/dp/0205654770/ref=sr_1_2?s=books-intl-de&ie=UTF8&qid=1317208260&sr=1-2)

Prerequisites / notice
Determine with Prof. Dr. Michael Siegrist the chapters in "Zimbardo" which are compulsory reading

Read the two Psychology chapters (6 + 7) from the book of Prof. Roland W. Scholz
Mid-sized cities in Latin America are growing at unprecedented rates. The next decade will be decisive in terms of demographic and economic growth, creating a time window to respond to unprecedented demands on resources, such as land, water and energy.

Are these boomtowns doomed to follow the fate of megacities or will they successfully avoid the pitfalls of rapid urban development? This program is part of a three-year ambitious collaboration with the Inter American Development Bank’s Emerging and Sustainable Cities Initiative and the Swiss Ministry for Economic Cooperation (SECO). It will influence decision makers and engage with real issues.

ETH is teaming up with the leading Universidad del Norte in Colombia to focus on Barranquilla, a rapidly growing city of 1.2 million inhabitants on the Atlantic coast of Colombia. Following a period of decline, vast sums of foreign investment are now flowing into this port city, with the potential to reverse current inequalities and spark more sustainable development.

In a team, you will produce alternative urban scenarios for the redevelopment of Barranquillas Central Market. You will contribute your expertise and unpack the realities of sustainable development in a tropical climate. How can knowledge from the ETH be combined with leading Colombian research and translated to a Latin American context? Through debate, controversy and collaboration it is expected you produce scenarios that integrate your different disciplines and question the preconceptions of sustainable urban development.

This immersive summer school will be structured in three interlocking modules:

In the first module you will investigate the central market and gain a strong understanding of the social, environmental and built context in Barranquilla. You will employ and combine your varied disciplinary methodologies to gain insight into the sustainability challenges facing the city and the redevelopment of the avenue.

In the second module, you will develop a series of scenarios for the central market in Barranquilla, proposing alternatives for its sustainable future. You will build on research from the first module, and explore the potential of your ideas with local stakeholders and professionals from your field. You will document these scenarios using creative and varied representational methods.

In the final module you will pitch your scenarios to decision makers. During this high-level event you will measure their preferences, debate the associated trade-offs, and provide a series of orientations for those planning the future of Barranquilla.

More information on our blog: www.marketsinthe tropics.com

Who should apply?

Enthusiastic students currently enrolled in a masters program in ETH Zurich and Universidad del Norte, Barranquilla Colombia. A balanced group of 12 ETH master students from the D-ARCH, D-USYS and D-BAUG departments will be selected. They will be joined by 12 Colombian students from our partner university in Barranquilla, Universidad del Norte.

Applicants should have a strong interest in sustainable urban development and trans disciplinary collaborative research. They should be able to demonstrate their academic strength, motivation, interest and expertise. Knowledge of Spanish is welcomed but not obligatory.

ETH participants will be charged a fee of 300 CHF to cover local activities, travel and accommodation.

Students will be responsible for organising visa, health insurance, and transportation to and from Barranquilla. Flights to Barranquilla from Zurich cost approximately 1700 CHF. Additional travel grants are available for ETH students.

Applications can be submitted including curriculum vitae, portfolio where relevant and letter of motivation as portable document format (pdf) by May 30th, 17:00 CET to hertzog@usys.ethz.h

Notification for admission June 1st.

Environmental Sciences Master - Key for Type

| Key for Type | W+ | Eligible for credits and recommended | W  | Eligible for credits | E- | Recommended, not eligible for credits | Z  | Courses outside the curriculum | Dr | Suitable for doctorate | O  | Compulsory |

Key for Hours

<table>
<thead>
<tr>
<th>Key for</th>
<th>V</th>
<th>lecture</th>
<th>G</th>
<th>lecture with exercise</th>
<th>U</th>
<th>exercise</th>
<th>S</th>
<th>seminar</th>
<th>K</th>
<th>colloquium</th>
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<tbody>
<tr>
<td>ECTS</td>
<td></td>
<td>practical/laboratory course</td>
<td></td>
<td>independent project</td>
<td></td>
<td>diploma thesis</td>
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<td>revision course / private study</td>
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Special students and auditors need special permission from the lecturers.
### High Performance Computing for Science and Engineering (HPCSE) I

**Number:** 151-0107-20L  
**Title:** High Performance Computing for Science and Engineering (HPCSE) I  
**Type:** W  
**ECTS:** 4 credits  
**Hours:** 4G  
**Lecturers:** P. Koumoutsakos, M. Troyer

**Abstract:**  
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective:**  
Introduction to HPC for scientists and engineers

**Fundamental of:**  
1. Parallel Computing Architectures  
2. MultiCores  
3. ManyCores

**Content:**  
Programming models and languages:  
1. C++ threading (2 weeks)  
2. OpenMP (4 weeks)  
3. MPI (5 weeks)

Computers and methods:  
1. Hardware and architectures  
2. Libraries  
3. Particles: N-body solvers  
4. Fields: PDEs  
5. Stochastics: Monte Carlo

**Lecture notes:**  
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

Class notes, handouts

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### Fluid Dynamics with the Lattice Boltzmann Method

**Number:** 151-0213-00L  
**Title:** Fluid Dynamics with the Lattice Boltzmann Method  
**Type:** W  
**ECTS:** 4 credits  
**Hours:** 3G  
**Lecturers:** I. Karlin

**Abstract:**  
The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.

**Objective:**  
Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.

**Content:**  
The course builds upon three parts:  
I Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.  
II Theoretical basis of statistical mechanics and kinetic equations.  
III Lattice Boltzmann method for real-world applications.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:  
   - Particle's distribution function, Liouville equation, entropy, ensembles;  
   - Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions;  
   - Mean-field interactions, Vlasov equation;  
   - Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:  
   - Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:  
   - Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:  
   - Lattice Boltzmann simulations of turbulent flows;  
   - Numerical stability and accuracy.

5. Microflow:  
   - Rarefaction effects in moderately dilute gases;  
   - Boundary conditions, exact solutions to Couette and Poiseuille flows;  
   - Micro-channel simulations.

6. Advanced lattice Boltzmann methods:  
   - Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers;  
   - Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:  
   - Relativistic fluid dynamics;  
   - Flows with phase transitions.

**Lecture notes:**  
Lecture notes on the theoretical parts of the course will be made available.  
Selected original and review papers are provided for some of the lectures on advanced topics.

**Prerequisites / notice:**  
The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.
Materials Technology

Introduction to Plasmonics

Abstract
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials.

Objective
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The lecture is part of the focus "Energy, Flows & Processes" on the Bachelor level and is recommended as a basis for a future Master in the area of energy. It is also a facultative lecture on Master level in Energy Science and Technology and Process Engineering.

Content

Lecture notes
HANDOUTS are EXCLUSIVELY IN GERMAN ONLY; however recommendations for English text books will be provided.

Literature

Mass Transfer

Abstract
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

Objective
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

Content
Fundamentals of Plasmonics
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

Lecture notes
Class notes and handouts

Literature

Prerequisites / notice
Literature

Handouts during the class

TEACHING LANGUAGE IN CLASS is German OR English (ON DEMAND).

Mass Transfer

Abstract
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Objective
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Literature


Prerequisites / notice
Three tests are offered for practicing the course material. Participation is voluntary.

Rate-Controlled Separations in Fine Chemistry

Abstract
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Objective
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content
The class covers separation techniques that are central in the purification and downstream processing of chemicals and bio-pharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Lecture notes
Handouts during the class

Literature

Recommendations for text books will be covered in the class

Prerequisites / notice
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

Process Design and Safety

Abstract
Process design and safety deals with the fundamentals of process apparatus, plant design and safety. The goal of the lecture is to expound design characteristics of systems for process engineering applications.

Objective

151-0917-00L

151-0917-00L

151-0927-00L

151-0951-00L
Content
Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry

Lecture notes
Script is available, English slides will be distributed

Literature

151-0957-00L
Practica in Process Engineering I
W 2 credits 2P D. J. Norris, P. Rudolf von Rohr
Prerequisites: "Einführung in Verfahrenstechnik" (151-0973-00L) and further process engineering courses.

Abstract
Practical training at pilot facilities for fundamental processing steps, typical laboratory and pilot facility experiments.

Objective
Getting acquainted with unit operations, measuring tools and data processing

Content
6 practica in total (2 from Prof. Norris, 4 from Prof. Rudolf von Rohr), details on dates are available at the beginning of the semester in ML H 14 and on our website

Mixing in Batch reactors
Rudolf von Rohr

Heat transfer
Rudolf von Rohr

Thinfilm evaporator
Rudolf von Rohr

Residence time distribution
Rudolf von Rohr

529-0613-00L
Process Simulation and Flowsheeting
W 7 credits 3G E. Capón García, K. Hungerbühler

Abstract
This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies. Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems.

Objective
This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:
- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modeling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.

Content
Overview of process simulation and flowsheeting
- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

Process modeling
- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

Process simulation
- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

Process optimization and analysis
- Classification of optimization problems
- Linear programming
- Non-linear programming
- Dynamic programming
- Optimization methods in process flowsheeting
- Sequential methods
- Simultaneous methods

Commercial software for simulation: Aspen Plus
- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging
Prerequisites / notice
A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.

636-0001-00L
Separations in Biotechnology and Bioprocess
Economy
W  6 credits  3G  S. Panke

Abstract
Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

Objective
Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Content
Introduction, membrane operations, adsorption and chromatography, crystallization, overall process economics.

Lecture notes
Handouts during course.

626-0007-00L
Microbial Biotechnology
Economy
W  6 credits  3V  S. Panke

Abstract
Introduction into the field of microbial biotechnology, covering possible products, fermentation and downstream technology.

Objective
The student should be able to identify opportunities for microbial bioprocesses and to go through basic and advanced design procedures for microbial bioprocesses.

Content
Students will obtain a thorough overview over microbial biotech products and the elements of bioprocess design: cellular growth and its modelling; mass transfer in fermentation; bioreaction engineering; bioreactors; downstream processing.

Lecture notes
Handout in class.

Literature
eg Nielsens/Villadsen, Bioreaction Engineering Principles (Kluwer) van ’t Riet/Tramer: Basic bioreactor design
Stephanopoulous/Aristidou/Nielsen: Metabolic Engineering
Prerequisites: Fundamentals in Chemistry and Biology (eg Bio-Engineering 151-0600-00)

151-0185-00L
Radiation Heat Transfer
Economy
W  4 credits  2V+1U  A. Steinfeld, A. Z’Graggen

Abstract
Advanced course in radiation heat transfer

Objective
Fundamentals of radiative heat transfer for high-temperature applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.

Content

Lecture notes
Copy of the slides presented.

Literature

151-0104-00L
Uncertainty Quantification for Engineering & Life Sciences
Economy
W  4 credits  3G  J. Beck, P. Koumoutsakos

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multilcore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will largely be based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

151-0509-00L
Microscale Acoustofluidics
Economy
W  4 credits  3G  J. Dual

Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective
Understanding acoustophoresis, the design of devices and potential applications

Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microbotics to surface acoustic wave devices

Lecture notes

Literature

Prerequisites / notice
Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.
Multidisciplinary Courses

The students are free to choose individually from the entire course offer of ETH Zurich, ETH Lausanne and the Universities of Zurich and St. Gallen.

Course Catalogue of ETH Zurich

Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1008-00L</td>
<td>Semester Project Process Engineering</td>
<td>O</td>
<td>8</td>
<td>17A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

Abstract

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Objective

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1012-00L</td>
<td>Industrial Internship Process Engineering</td>
<td>O</td>
<td>8</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective

The main objective of the 12-week internship is to expose master's students to the industrial work environment.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MAVT.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1005-00L</td>
<td>Master's Thesis Process Engineering</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their Master Thesis:

a. Successful completion of the Bachelor programme
b. Any additional requirements for admission to the degree programme have been fulfilled
c. Successful completion of the Semester Project and Industrial Internship (the corresponding credits have been acquired)

The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

To choose an adjunct professor of D-MAVT as a supervisor (http://www.mavt.ethz.ch/people/adjunct/index), please contact the Student Administration Office of D-MAVT.

Abstract

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Seminars, Colloquia, and Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0950-00L</td>
<td>Acoustics</td>
<td>E-</td>
<td>0</td>
<td>0.5K</td>
<td>K. Heutschi</td>
</tr>
</tbody>
</table>

Current topics in Acoustics presented mostly by external speakers from academia and industry.

Objective

see above

151-0933-00L | Seminar on Advanced Separation Processes | E- | 0 credits | 1S | M. Mazzotti |

Research seminar for master's students and doctoral students

Objective

Research seminar for master's students and doctoral students

227-0920-00L | Seminar in Systems and Control            | E- | 0 credits | 1S | F. Dörfler, R. D'Andrea, J. Lygeros, R. Smith |

Objective

Current topics in Systems and Control presented mostly by external speakers from academia and industry

see above

227-0970-00L | Research Topics in Biomedical Engineering | E- | 0 credits | 2K | M. Rudin, S. Kozerke, K. P. Prüssmann, M. Stamparoni, K. E. Stephan, J. Vörös |

Objective

Current topics in Biomedical Engineering presented by speakers from academia and industry.

Getting insight into actual areas and problems of Biomedical Engineering an Health Care.

151-0931-00L | Seminar on Particle Technology            | E- | 0 credits | 3S | S. E. Pratsinis |

Objective

Current topics in Biomedical Engineering presented by speakers from academia and industry.

Getting insight into actual areas and problems of Biomedical Engineering an Health Care.
Abstract

The goal of the lecture is to convey a basic knowledge in the area of FV materials as well as their construction and production processes and to empower the students to apply the knowledge gained to address current problems in research and practice.

Objective

Students attend and give research presentations for the research they plan to do and at the end of the semester they defend their results and answer questions from research scientists. Familiarize the students with the latest in this field.

401-5650-00L Zurich Colloquium in Applied and Computational Mathematics

Abstract

Research colloquium

401-5640-00L ZüKoSt: Seminar on Applied Statistics

Abstract

About 5 talks on applied statistics.

Objective

See how statistical methods are applied in practice.

Content

There will be about 5 talks on how statistical methods are applied in practice.

Prerequisites / notice

This is no lecture. There is no exam and no credit points will be awarded. The current program can be found on the web:
http://stat.ethz.ch/events/zukost

Course language is English or German and may depend on the speaker.

Process Engineering Master - Key for Type

| O  | Compulsory | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |
| W  | Eligible for credits | Dr | Suitable for doctorate |

Key for Hours

| V  | lecture | P | practical/laboratory course |
| G  | lecture with exercise | A | independent project |
| U  | exercise | D | diploma thesis |
| S  | seminar | R | revision course / private study |
| K  | colloquium | |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.