

Master of Science in Physics - Master of Science in Physics

Semester 1

	Vorlesung (UE)	Übung (UE)	ECTS
Module 1.1			6
Solid State Physics	70	20	6
Module 1.2			4
Physics of Living Matter	30	15	4
Module 1.3			4
Computational Methods	30	15	4
Module 1.4			4
Colloids and Liquid Crystals	30	15	4
Module 1.5			4
Laser Physics	30	15	4
Module 1.6			4
Classical and Quantum Information Theory	45		4
Module 1.7			2
Advanced Materials Characterization Techniques	30		2
Module 1.8			0
Partial Differential Equations I (Optional)	30	30	8
Discrete-time stochastic processes (Optional)	30	15	6
111 Lernen und schulisches Lernen (Optional)	30		4
ISB701: Introduction to Systems Biology (Optional)	30	40	4
Physics didactics 1 (Optional)	30		3
Computational Fluid Dynamics (Optional)	30		3
Communicating science (Optional)	24		3

Master of Science in Physics - Master of Science in Physics

Semester 2

	Vorlesung (UE)	Übung (UE)	ECTS
Module 2.1			4
Ferroelectrics and multiferroics	30	15	4
Module 2.2			4
Astrophysics and Cosmology	30		4
Module 2.3			4
Classical and Quantum Transport	30	15	4
Module 2.4			4
Semiconductors and Solar Cells	30	15	4
Module 2.5			4
Polymer Physics	30	15	4
Module 2.6			6
Lab class		120	6
Module 2.7			2
Literature Seminar	30		2
Module 2.8			4
Business Game simulation	12		1
Ideation Camp 7th edition	60		3
Probability (stochastic analysis) (Optional)	45		5
Principles of Software Development (Optional)	30		5
Knowledge Discovery and Data Mining (Optional)	30	15	5
Partial Differential Equations II (Optional)	45		5
Didactics for Physics 2 (Optional)	30		3

Master of Science in Physics - Master of Science in Physics

	Vorlesung (UE)	Übung (UE)	ECTS
Advanced engineering materials (Optional)	45		4
Academic English B2.2 (Optional)	30		2
Academic English C1.2 (Optional)	30		2

Semester 3

	Vorlesung (UE)	Übung (UE)	ECTS
Module 3.1			30
Lab Class in Preparation for Master Thesis	375		27
Seminar on the Master Thesis Topic	30		3

Semester 4

	Vorlesung (UE)	Übung (UE)	ECTS
Module 4.1			30
Master Thesis		375	20
Defense of Master Project	30		10

Master of Science in Physics - Master of Science in Physics

Semester 1

Solid State Physics

Modul: Module 1.1 (Semester 1)

ECTS: 6

Objektiv: The course introduces the students to the atomic and electronic structure of solid crystalline materials. The goal of solid-state physics is to understand the macroscopic properties (such as hardness, color, electrical conductivity, heat capacity, etc.) from the microscopic structure of the material. The lattice dynamics (phonons) of crystalline materials will be studied in order to understand the thermal properties of matter. The electronic structure of metals, semiconductors, and insulators will be treated in detail, as well as their optical properties.

Course learning outcomes: A student who passes this course will be able to:

- explain the most common crystal structures and their determination by X-ray scattering
- describe the reaction of crystals to various stresses
- understand the storage and transport of heat in solids
- explain the difference between metals, semiconductors and insulators based on their electronic structure
- understand the link between optical properties and electronic excitations

The course will enable the student to study the literature on current research topics in the field of solid-state physics.

Beschreibung:

- crystal structures (reciprocal lattice, X-ray diffraction, crystal bonds, crystal defects)
- elastic properties (continuum mechanics, elastic tensors)
- phonons (quantisation, dispersion, Debye and Einstein model, specific heat and heat conduction)
- electrons (band structure, Sommerfeld model, Bloch functions, quasi free electrons, tight binding model, defects in semiconductors)
- solid state optics (model dielectric functions, electronic transitions)
- superconductivity

Modalitäten: Lecture + TD

Sprache: Anglais

Pflichtkurs: Oui

Evaluation: TD and oral exam

Remark: Support :
Lecture Slides
Literature :
- C. Kittel, Introduction to Solid State Physics, Wiley
- H. Ibach and H. Lüth, Solid-State Physics, An Introduction to Principles of Materials Science, Springer

Master of Science in Physics - Master of Science in Physics

- N.W. Ashcroft and N.D. Mermin, Solid State Physics, Saunders College Publishing
- Rudolf Gross, Achim Marx, Festkörperphysik, Oldenbourg Verlag (in German)
- P. Yu and M. Cardona, Fundamentals of Semiconductors: Physics and Materials Properties, Springer
- K. Kopitzki, Einführung in die Festkörperphysik, Teubner (in German)
- G. Burns, Solid State Physics, Academic Press, used only

Professor: DALE Phillip, REDINGER Alex, ROMMELFANGEN Jonathan

Physics of Living Matter

Modul: Module 1.2 (Semester 1)

ECTS: 4

Objektiv: Cross Disciplinary course in Biological Physics targeted to Masters and PhD level students from PhyMS RU, LS RU, LCSB, RU ES, LIH, and LIST.

The cross-disciplinary field of biophysics has seen major expansion in the recent years, thanks to the advancements in physical, engineering and computational tools. Luxembourg is at the forefront of scientific activities in biological physics with its exciting landscape of experimental and theoretical research on biological questions that require a strong quantitative physical approach. The Physics and Materials Research Unit offers an introduction to this exciting interdisciplinary field, interfacing fluid mechanics, microbiology (of virus, bacteria, and algae), physical ecology, and materials physics. This course will explore how quantitative approaches in biological sciences could provide a mechanistic framework for the rich myriad of emergent phenomena observed in living systems.

Main Objectives

1. To be able to quantify biological processes at the level of individual cells, populations, and multi-species communities, and their relation to the environments they inhabit.
2. To have an overview of the main relevant experimental and statistical tools, and respective working principles, relevance, and limitations.
3. To understand cross-interactions between cellular behavior and physiology.
4. To understand how single cell dynamics lead to emergent functional properties at the scale of population and communities.

Course learning outcomes:

A student who passes this course will be able to:

- Identify and quantitatively analyze biological systems and their dynamics, and suggest underlying physical principles driving biological functions.
 - Propose appropriate methods and tools for tracking and analyzing biological processes, and comment on the statistical significance of the obtained data.
 - Analyze the impact of changes in the environmental conditions, whether induced artificially or due to natural patterns in the ecosystem.
 - Identify original problems from biological systems, relevant from environmental and human sciences, and develop testable hypotheses toward investigating these open questions.
- This course will enable the student to read, understand, and analyze academic literature related to biological physics in a wide range of contexts. The course provides a fundamental basis to follow more advanced courses in biophysics, in particular those related to biological transport processes, emergent phenomena and the inter-relation of form and function in biology.

Beschreibung: Core Topics

Master of Science in Physics - Master of Science in Physics

- Physics of cell: random walks, transport processes, molecular motors, and active matter
 - Life at micro-scales; fluctuations and dissipation in the cell
 - Scaling up single cell physics to population and community scales
 - Living in fluctuating environments
- Tools and Techniques
- Live cell imaging, spectroscopy, and image analysis
 - Microfluidics, micromanipulation, and optical techniques
 - Complex systems approach: probabilistic, deterministic, and network analyses
 - Biostatistics: Statistical tools and inference in biological systems

Modalitäten:	Lecture and Tutorial & Discussions
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	Tutorial & Discussions, powerpoint presentations, and oral exam
Remark:	Support : Lecture slides available on the course website Literature : Relevant course books: Physical Biology of the Cell by Phillips, Kondev, Theriot and Garcia (ISBN: 0815344503) Random Walks in Biology by Howard C Berg (ISBN: 0691000646) E. coli in motion by Howard C Berg (ISBN: 978-0387008882) A Mechanistic Approach to Plankton Ecology by Thomas Kiørboe (ISBN: 978-0691134222)
Professor:	SENGUPTA Anupam, ONG Irvine

Computational Methods

Modul:	Module 1.3 (Semester 1)
ECTS:	4
Objektiv:	<p>The main idea of the course is to provide knowledge and practical experience of the numerical techniques that constitute the basis of Computational Physics and Chemistry. Each lecture will be comprised of an introduction to the theory behind a given technique, followed by a practical session centered on its implementation and application for well-known problems. Some emphasis will be put on the analysis of the outcome of the variation of physical parameters for the given problem.</p> <p>The first part of the course will consolidate simple notions of python3 programming and cover the basic algorithms necessary to solve simple equations. The second part will provide an introduction on more advanced methods such as Monte Carlo and Machine Learning, as well as cover the numerical solution of the time-dependent Schrödinger equation and molecular dynamics.</p>
Course learning outcomes:	<ul style="list-style-type: none">• knowledge of standard algorithms adopted in computational Physics and Chemistry and their limitations• capability of writing a program to find the numerical solution of simple physical problems and analyze the resulting data• understanding the basics of Monte Carlo methods, molecular dynamics simulations and machine learning

Master of Science in Physics - Master of Science in Physics

Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	TD
Remark:	<ol style="list-style-type: none">1. Numerical Methods for Scientists and Engineers, Richard W. Hamming (Dover publications)2. Numerical Recipes series, William H. Press, Saul A. Teukolsky, William T. Vetterling and Brian P. Flannery (Cambridge university press)3. Numerical Methods, E. A. Volkov (Hemisphere publishing corporation)4. https://www.codecademy.com/learn/learn-python-35. https://www.learnpython.org/en/
Professor:	TKATCHENKO Alexandre, KHABIBRAKHMANOV Almaz, GALANTE Mario

Colloids and Liquid Crystals

Modul:	Module 1.4 (Semester 1)
ECTS:	4
Objektiv:	<p>The objective of this course is to introduce students to the world of colloids and liquid crystals and make them discover these soft states of matter with their distinctive and useful physical properties.</p> <p>Main Objectives</p> <ol style="list-style-type: none">1. To understand what a liquid crystal is and the consequences of its anisotropic properties;2. To be able to identify colloidal systems, understand the key colloidal scale interactions and the physics of colloid stabilization and destabilization;3. To account for the various self-assembly/self-organization processes that take place in colloidal dispersions and liquid crystals, correlating nano- and microstructure with macroscopic properties;4. To get acquainted with the theories for describing colloids and liquid crystals;5. To get an overview of the main relevant preparation and characterization tools and their respective working principles, advantages and limitations.
Course learning outcomes:	<p>A student who passes this course will be able to:</p> <ul style="list-style-type: none">- Identify liquid crystalline and colloidal systems and describe, prepare and analyze them using the proper physics and physical chemistry tools, both in terms of concepts and experimental equipment;- Explain the characteristics of the two main classes of liquid crystals and account for their typical phase behavior in response to relevant thermodynamic control parameters.- Describe the concept of liquid crystal director and account for its relation to macroscopic properties, its interaction with electric and magnetic fields, as well as the consequences of director field deformations.- Master the concept of an order parameter and apply it to describe phase transitions as well as to correlate characteristics on the molecular and macroscopic scales.- Elucidate the propagation of light in liquid crystals and colloids, in particular considering anisotropy (birefringence), periodic internal structures (structural color) and refractive index heterogeneity (scattering).- Illustrate the basic mechanism of function of liquid crystal displays.

Master of Science in Physics - Master of Science in Physics

- Define the conditions for colloidal stability or instability, accounting for the effect of salts.
 - Account for the impact of colloid dispersity and how it can be reduced by fractionation.
- This course will enable the student to read the academic literature dealing with the fundamental properties of liquid crystals and colloids. It also provides a firm basis to follow more advanced courses in soft condensed matter.

- Beschreibung:**
- Definition of colloids and liquid crystals and the key concepts for describing them.
 - Overview of liquid crystal classes (thermotropic/lyotropic) and phases (nematic, cholesteric, smectic, ...) and colloid types (associated/unassociated, suspensions, emulsions, gels, ...).
 - Self-assembly and self-organization.
 - Basics of optics of anisotropic media and application to the case of liquid crystals.
 - Liquid crystal elasticity and topological defects.
 - Dielectric/magnetic properties of liquid crystals; response to electric/magnetic fields.
 - Design and function of liquid crystal displays (LCDs).
 - Chiral systems and their peculiar properties.
 - Key colloidal interactions: van der Waals attraction (and analysis by the Hamaker approach), hydrogen bonding, hydrophobic effect, electrostatic interactions in liquids, capillary forces.
 - Poisson-Boltzmann and DLVO theories; electrostatic double layer, Debye screening length, hydrodynamic radius, Zeta potential, ionic strength, electrostatic screening.
 - Steric versus electrostatic stabilization. Destabilization using salt, polymer bridging or depletion attraction. Sedimentation, centrifugation and flocculation.
 - Solvent evaporation, wetting, and the effects of capillary forces. Ostwald ripening.
 - Experimental methods for investigating colloids and liquid crystals and their properties.

Modalitäten: Lecture and TD

Sprache: Anglais

Pflichtkurs: Oui

Evaluation: TD, mid-term exam and oral final exam

Remark: Support :
Lecture slides available on Moodle

Literature :

Main course books:

Introduction to Liquid Crystals: Chemistry and Physics, by Peter J. Collings, Michael Hird, CRC Press, ISBN-13: 9780748404834 - CAT# TF1996

"An Introduction to Interfaces & Colloids; The bridge to Nanoscience" by John C. Berg, World Scientific Press, ISBN-13: 978-981-4293-07-5

Support books for specific topics:

The Physics of Liquid Crystals by P.G. de Gennes, J. Prost, Oxford University Press, ISBN-13: 978-0198517856

"Intermolecular And Surface Forces" by Jacob Israelachvili, Academic Press, ISBN: 0123751829

Professor: SCALIA Giusy



Master of Science in Physics - Master of Science in Physics

Laser Physics

Modul: Module 1.5 (Semester 1)

ECTS: 4

Objektiv: The objective of this course is to introduce students to lasers and the fundamental concepts in optics and physics that are at the basis of their operations.

Main Objectives

1. To understand what is a laser and how it works
2. To understand the properties of a laser beam
3. To know fundamental aspects of interaction between light and matter
4. To learn what are the principal uses of lasers in a scientific environment
5. To understand different type of lasers and different regimes of operation
6. To introduce nonlinear optics

Course learning outcomes:

A student who passes this course will be able to:

- Describe the physical processes that make possible a laser
 - Explain what are the fundamental ingredients in a laser and what is their role in the lasing action
 - Describe the propagation of a laser beam
 - Elucidate the coherence properties of the light emitted by a laser
 - Describe the continuous and pulsed operation regimes
 - List typical laser and explain their peculiarities
 - Explain the fundamental aspects of nonlinear optics
 - Describe the main scientific applications of laser light
- This course will enable the student to read the academic literature dealing with laser physics and acquire knowledge useful in advanced courses of optics and photonics.

Beschreibung:

- Spontaneous and stimulated emission
- Gain media and rate equations
- Laser cavity and relative modes
- Solid state lasers
- Gas lasers
- Semiconducting lasers
- Coherence of laser radiation
- Propagation of a Gaussian beam
- Q-switching and mode locking
- Introduction to nonlinear optics
- Lasers in science

Modalitäten: Lecture and TD

Sprache: Anglais

Pflichtkurs: Oui

Evaluation: TD, powerpoint presentations, and oral exam



Master of Science in Physics - Master of Science in Physics

Remark: Support :
Lecture slides
Literature :
Book:
Principles of Lasers, by O. Svelto, Springer, ISBN 978-1-4419-1302-9
Advanced Book:
Ultrafast Optics, by A.M. Weiner, Wiley, ISBN 978-0-471-41539-8

Professor: BRIDA Daniele, ROJAS AEDO Ricardo Arturo

Classical and Quantum Information Theory

Modul: Module 1.6 (Semester 1)

ECTS: 4

Beschreibung: Over the last decades, physics has evolved to identify the role of information as a unifying umbrella, transforming the understanding of biophysics, statistical mechanics, and condensed matter theory. Quantum Information theory has emerged as a new field merging physics, information theory, and computer science.

This course covers elements of information theory both in the classical and quantum level. The first part introduces the elements of the classical theory, presenting essential topics such as information measures, channel capacity, hypothesis testing, complexity and information geometry. The second part focuses on the quantum information science, including measurement theory, quantum metrology, quantum information processing, and quantum computation.

Modalitäten: Lecture and TD

Sprache: Anglais

Pflichtkurs: Oui

Remark: References:
J. A. Thomas and T. M. Cover, Elements of Information Theory , 2nd ed. (Wiley , 2006)
Isaac Chuang, Michael Nielsen, Quantum Computation and Quantum Information (Cambridge, 2000).

Professor: DEL CAMPO ECHEVARRIA Adolfo, POLETTINI Matteo

Advanced Materials Characterization Techniques

Modul: Module 1.7 (Semester 1)

ECTS: 2

Master of Science in Physics - Master of Science in Physics

Objektiv:	This course aims at introducing the students to the background of several advanced experimental methods in Solid State and Materials Physics
Course learning outcomes:	The student who passes this course will be able: - to describe the theoretical background of the discussed methods - to apply the methods to concrete problems in solid state and materials physics
Beschreibung:	1. Phonon spectroscopy a) Raman spectroscopy b) Infrared spectroscopies c) Inelastic neutron and X-ray scattering d) Introduction to Group Theory for phonon spectroscopy 2. Photo-electron spectroscopy a) X-ray and UV Photon-Spectroscopy b) Auger Spectroscopy 3. Nano- and atomic scale imaging and analysis a) Introduction to charged particle optics b) Electron microscopy (SEM & TEM) c) Secondary Ion Mass Spectroscopy (SIMS) d) Atom Probe Tomography (APT) e) Helium Ion Microscopy (HIM)
Modalitäten:	Lecture
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	Oral examination (30 minutes)
Remark:	Support : PowerPoint presentation (distributed before lecture)
Professor:	KREISEL Jens, WIRTZ Tom

Partial Differential Equations I

Modul:	Module 1.8 (Semester 1)
ECTS:	8
Objektiv:	The goal of the course is to get acquainted with Partial differential equations (PDE) as a powerful tool for modeling problems in science, providing functional analytic techniques in order to deal with PDE.
Course learning outcomes:	On successful completion of the course the student should be able to: <ul style="list-style-type: none">• Apply methods of Fourier Analysis to the discussion of constant coefficient differential equations• Work freely with the classical formulas in dealing with boundary value problems for the Laplace equation• Prove acquaintance with the basic properties of harmonic functions (maximum principle, mean value property) and solutions of the wave equation (Huygens property)• Solve Cauchy problems for the heat and the wave equations

Master of Science in Physics - Master of Science in Physics

	<ul style="list-style-type: none">• Give a pedagogic talk for peers on a related topic
Beschreibung:	Fourier transform, the classical equations, spectral theory of unbounded operators, distributions, fundamental solutions.
Modalitäten:	Lecture course
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	Written exam
Remark:	1. Rudin: Functional analysis 2. Jost: Postmodern analysis 3. Folland: Introduction to partial differential equations. 4. Reed-Simon: Methods of mathematical physics I-IV
Professor:	OLBRICH Martin, GROTTO Francesco, EL EMAM Christian

Discrete-time stochastic processes

Modul:	Module 1.8 (Semester 1)
ECTS:	6
Objektiv:	Introduction to basic concepts of modern probability theory
Course learning outcomes:	On successful completion of the course, the student should be able to: <ul style="list-style-type: none">• Understand and use concepts of modern probability theory (e.g., filtrations, martingales, stopping times)• Apply the notion of martingale to model random evolutions• Know and apply classical martingale convergence theorems• Describe and manipulate basic properties of Brownian motion
Beschreibung:	Filtrations, conditional expectations, martingales, stopping times, optional stopping, Doob inequalities, martingale convergence theorems, canonical processes, Markov semigroups and processes, Brownian motion.
Modalitäten:	Lecture course
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	Written exam
Remark:	H. Bauer, Wahrscheinlichkeitstheorie D. Williams, Probability with Martingales
Professor:	PILIPAUSKAITE Vytautė

Master of Science in Physics - Master of Science in Physics

111 Lernen und schulisches Lernen

Modul:	Module 1.8 (Semester 1)
ECTS:	4
Course learning outcomes:	<p>Nach Abschluss der Vorlesungsreihe können die Studierenden</p> <ul style="list-style-type: none">• Grundprinzipien, Konzepte, Gemeinsamkeiten bzw. Unterschiede der klassischen und aktuellen Lerntheorien beschreiben;• menschliches Lernen in seiner Besonderheit verstehen;• erörtern, wie Schulkinder (voneinander) lernen;• behandelte Konzepte an Beispielen aus dem schulischen Alltag anwenden;• Lehr/Lernarrangements in einen lerntheoretischen Rahmen stellen;
Beschreibung:	<p>Der Kurs bietet einen Überblick über das komplexe Themenfeld „Lernen in der Schule“. Folgende lerntheoretischen Zugänge und Strömungen aus unterschiedlichen disziplinären sowie interdisziplinären Kontexten werden in der Vorlesung vorgestellt und diskutiert:</p> <ul style="list-style-type: none">• behavioristischer Ansatz• kognitivistischer Ansatz• konstruktivistische Ansätze• neurobiologische Ansätze• soziokonstruktivistische/soziokulturelle Ansätze• erziehungswissenschaftliche/pädagogische Ansätze <p>Bibliographie:</p> <ul style="list-style-type: none">• Giordan, A. (2016). Apprendre ! Paris : Editions Belin.• Kölbl, C. (2006). Die Psychologie der kulturhistorischen Schule. Vygotskij, Lurija, Leont'ev. Göttingen: Vandenhoeck & Ruprecht.• Sunnen, P. (2011). Lernen. Ausführungen zum erziehungswissenschaftlichen Lernbegriff bei Gerold Scholz. In H. de Boer, H. Deckert-Peaceman & K. Westphal (Hg.), Irritationen – Befremdungen – Entgrenzungen. Fragen an die Grundschulforschung (S. 191-215). Frankfurt/Main: Goethe Universität Frankfurt/Main.• Vosniadou, S. (2001). How children learn. Educational Practices Series, 7. Geneva: International Academy of Education, International Bureau of Education.• Winkel, S., Peterman, F., & Peterman, U. (2006). Lernpsychologie. Paderborn: UTB. <p>Weitere Literatur wird in der Vorlesung bekanntgegeben.</p>
Sprache:	Allemand, Français, Anglais
Pflichtkurs:	Non
Evaluation:	Klausur
Professor:	SUNNEN Patrick

Master of Science in Physics - Master of Science in Physics

ISB701: Introduction to Systems Biology

Modul:	Module 1.8 (Semester 1)
ECTS:	4
Objektiv:	Getting an overview on the elements of systems biology and its concepts Ability to analyze biological processes by systems biology methods and concepts Understanding of the principles of systems biology, such as topology, stoichiometrics and kinetics
Course learning outcomes:	<ol style="list-style-type: none">1. Recall and apply key procedures and methods in mathematics and bioinformatics.2. Differentiate the key principles of bottom-up systems biology.3. Integrate basic understanding of bottom-up systems biology by designing, creating and analyzing models.
Beschreibung:	Definition of systems biology Basic concepts in systems biology Biophysical basis of enzyme reactions Reconstruction of biochemical networks Metabolic networks Basic features of the stoichiometric matrix Topological properties
Modalitäten:	Lectures
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	Written exam
Remark:	Learning material: Lecture slides, PDF-files of review articles
Professor:	SAUTER Thomas

Physics didactics 1

Modul:	Module 1.8 (Semester 1)
ECTS:	3
Objektiv:	<ul style="list-style-type: none">• découvrir la richesse de l'enseignement de la physique• planifier et vivre des situations d'enseignement en classe

Master of Science in Physics - Master of Science in Physics

- planifier des expériences de démonstration
- analyser ses propres performances pour mieux s'orienter dans son choix professionnel
- comprendre l'enseignement de la physique au secondaire et secondaire technique

Course learning outcomes: Connaître les multiples facettes de l'apprentissage et de l'enseignement de la physique et les défis posés à l'enseignant.

Modalitäten: cours magistraux, travail indépendant, travaux pratiques, travaux dirigés

La connaissance et la maîtrise de ces deux langues (Français & Deutsch) est requise

Sprache: Français, Allemand

Pflichtkurs: Non

Evaluation: La présence à tous les cours est obligatoire.

Engagement régulier, élaboration d'un portfolio personnel (pièces créées à partir des éléments traités en cours), présentation du portfolio.

Remark: Conditions d'admission:
La connaissance et la maîtrise des langues française et allemande est requise

Notes de cours:

G. de Vecchi, L'enseignement scientifique, Delagrave, 2002, ISBN: 2-206-08471-6

H. Gudjons, Handlungsorientiert lehren und lernen, Klinkhardt, 2008, 2008, ISBN: 978-3-7815-1625-0

Kirchner Girwidz Häußler, Physikdidaktik, Springer, 2001, ISBN: 3-540-41936-5

H. Klippert, Methodentraining, Beltz 2005, ISBN: 3-407-62545-6

A.B. Arons Teaching Introductory Physics, Wiley, 1996, ISBN: 978-04711-37078

M. Reiss Understanding Science Lessons, Open University Press, 2001, ISBN: 978-0335-197699

H.K. Mikalsis (Hrsg.) Physik Didaktik, Cornelsen Scriptor, 2006, ISBN: 378-3589221486

Professor: EICHER Carol, MALLINGER Marc

Computational Fluid Dynamics

Modul: Module 1.8 (Semester 1)

ECTS: 3

Sprache: Anglais

Pflichtkurs: Non

Professor: PETERS Bernhard, AMINNIA Navid

Master of Science in Physics - Master of Science in Physics

Communicating science

Modul:	Module 1.8 (Semester 1)
ECTS:	3
Objektiv:	Learn to simplify without loss of accuracy when dealing with non-experts Know your audience Learn how to deal with nervousness Learn how to explain things simply Improvement of presentation skills (interactive, body language, pace)
Course learning outcomes:	Presentation skills Organizational skills Teaching skills Outreach skills
Beschreibung:	The course is a mix of theoretical introductions, practical experiences within the group and finally outreach activities in direct contact with the public (high school students, general public at events). All field work will be performed within the frame of the Scienceteens Lab's workshops. This requires some flexibility regarding the personal schedule.
Modalitäten:	Preparation and execution of field work (total: 24h of field work). All field work will be performed within the frame of the Scienceteens Lab's workshops and presence at events. Field work can be performed distributed over both semesters. This requires some flexibility regarding the personal schedule.
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	Active participation Attendance Written final project, report, presentation or movie
Remark:	Support : The course material is dynamically evolving within the group and part of the course process. Exemplary material will be provided and the participants can bring examples themselves. Literature : Pierre Laszlo: Communicating Science, A Practical Guide Carmine Gallo: Talk Like TED ...and many more
Professor:	REDINGER Alex

Master of Science in Physics - Master of Science in Physics

Semester 2

Ferroelectrics and multiferroics

Modul: Module 2.1 (Semester 2)

ECTS: 4

Objektiv: The lecture aims at

- introducing the student to the basic principles of ferroelectricity and related phenomena, including the simultaneous occurrence of (and interaction between) ferroelectricity and magnetism (magnetoelectric multiferroism),
- applying these principles to problems in fundamental and applied ferroelectricity and multiferroicity
- developing the ability to critically assess basic experimental and simulation results in the field

Course learning outcomes:

- After completion of the course, the student is expected to understand and explain
- the basic quantities and phenomenology of ferroelectricity and multiferroicity
 - the basic theoretical and experimental approaches in the field
 - the basic understanding of the main effects, at both atomistic and macroscopic levels
 - the basics of model ferroelectric and magnetoelectric multiferroic materials
 - the basics of the application of these materials in devices
 - the current trends in the field

Beschreibung:

- **Basics of dielectrics and ferroelectrics**
 - Electric polarization and dielectric response
 - Basic ferroelectric phenomenology
 - Ferroelectric materials, properties and applications
- **Ferroelectric phase transitions**
 - Ferroelectricity, an example of structural phase transition
 - Crystallographic and symmetry considerations
 - Landau theory of ferroelectric phase transitions
 - Soft phonon modes and response anomalies
 - Strain-related effects, ferroelasticity
 - Ferroelectric domains and domain walls

Master of Science in Physics - Master of Science in Physics

- Proper vs. improper ferroelectricity
- **Experimental characterization techniques**
 - Dielectric and vibrational spectroscopies
 - Diffraction methods for structural resolution
 - Local-probe microscopies
- **Theoretical approaches to ferroelectric phenomena**
 - Quantum mechanical first-principles simulations
 - Atomistic effective potentials, force fields
 - Continuum models, phase fields
- **Multiferroics (I)**
 - Review of basic concepts in magnetism and magnetic materials
 - Key magnetic and magnetostructural interactions
- **Multiferroics (II)**
 - Type I multiferroics (strong ferroelectric and magnetic orders)
 - Type II multiferroics (strong magnetic order, slave polar order)
 - Artificial multiferroics
- **Ferroelectrics and multiferroics in practice**
 - Applications of ferroelectrics
 - Applications of multiferroics
- **Advanced topics**
 - Photoferroelectrics
 - Ferroelectric nanostructures, field effects and emerging properties
 - Energy applications (harvesting, storage, cooling, etc.)
 - Ferroelectric and multiferroic memories

Modalitäten:	Lecture
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	Oral exam
Remark:	Support : Powerpoint presentation / blackboard Literature :

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M. E. Lines and A. M. Glass, Principles and Applications of Ferroelectrics and Related Materials (Clarendon Press, Oxford, 1977).

K. M. Rabe, C. H. Ahn and J.-M. Triscone, Physics of Ferroelectrics - A Modern Perspective(Springer, 2007).

B. A. Strukov and A. P. Levanyuk, Ferroelectric Phenomena in Crystals(Springer, 1998).

C. Kittel, Introduction to Solid State Physics (8 thedition)(John Wiley & Sons, 2005).

N. W. Ashcroft and N. D. Mermin, Solid State Physics(Harcourt College Publishers, 1976)

S. Blundell, Magnetism in Condensed Matter(Oxford University Press, 2001).

A. Aharoni, Introduction to the Theory of Ferromagnetism(Oxford University Press, 2000).

Professor: GUENNOU Mael, INIGUEZ Jorge

Astrophysics and Cosmology

Modul: Module 2.2 (Semester 2)

ECTS: 4

Sprache: Anglais

Pflichtkurs: Oui

Professor: HENKEL Malte

Classical and Quantum Transport

Modul: Module 2.3 (Semester 2)

ECTS: 4

Objektiv: In this course, students will learn to understand and describe transport phenomena in physical classical. Transport phenomena (electric current, heat transport, motion of fluids) are ubiquitous both in classical as well as in quantum physics. Starting from the important equations of classical transport theory (Boltzmann equation, Navier-Stokes equation) and the theory of open systems (Langevin and Fokker-Planck equations), we will move on to quantum systems, where we will mostly focus on electronic transport. The student should learn the basic techniques applicable to noninteracting systems (scattering theory) and interacting systems (Green's functions and master equations). Moreover, the students will learn to model nonequilibrium states in quantum systems (using for instance linear response theory or Keldysh technique).

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Course learning outcomes:	A student who takes this course will become familiar with the most important transport equations, which are ubiquitous in physics and engineering. He/she will understand how to derive them and how to solve them by applying them to simple situations.
Beschreibung:	<ul style="list-style-type: none">• Boltzmann equation and relaxation-time approximation• The Navier-Stokes formula for fluids• Heat and matter transport in irreversible thermodynamics• Langevin and Fokker-Planck equations for open systems• The fluctuation-dissipation theorem• Landauer-Büttiker formalism, scattering theory• Quantum master equation, Born-Markov approximation• Linear response theory, Kubo formula• Green's functions, non-equilibrium Keldysh technique
Modalitäten:	Lecture + TD
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	Written exam
Professor:	SCHMIDT Thomas

Semiconductors and Solar Cells

Modul:	Module 2.4 (Semester 2)
ECTS:	4
Objektiv:	This course aims at: <ul style="list-style-type: none">• giving a short overview/repetition on the electronic structure of semiconductors (bands and defects)• introducing the students to charge carrier statistics• educating the students on the optical properties of semiconductors• training the students in basics of pn and Schottky junctions• introducing the students to junctions under illumination and the functioning of solar cells• introducing the students to the thermodynamic balances in solar cells
Course learning outcomes:	A student who passes this course will be able to: <ul style="list-style-type: none">- understand the role of doping in semiconductors- describe qualitatively and quantitatively absorption and light emission in semiconductors- delineate qualitatively and quantitatively the behaviour of pn junctions in the dark and under illumination- explain qualitatively and quantitatively the efficiency limits in solar cells The course will enable the student to study the literature on current research topics in the field of semiconductor physics.
Beschreibung:	<ul style="list-style-type: none">• Electronic structure of semiconductors• Charge carrier statistics• Excitation and recombination• p/n junction in the dark and under illumination• The equilibria in a solar cells

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	• Schottky contacts and transistors
Modalitäten:	Lecture + TD
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	Intermediate written exam and final oral exam
Remark:	Support : Lecture Slides

Literature :

- R. F. Pierret, Advanced Semiconductor Fundamentals, Prentice Hall
- P. Yu and M. Cardona, Fundamentals of Semiconductors: Physics and Materials Properties, Springer
- K. Seeger, Semiconductor Physics, Springer
- S.M. Sze, K.K. Ng, Physics of Semiconductor Devices, Wiley
- P. Würfel, Physics of Solar Cells, Wiley
- M. Grundmann, The Physics of Semiconductors, Springer
- J. Pankove, Optical Processes in Semiconductors, Dover
- W. Mönch, Electronic Properties of Semiconductor Interfaces, Springer

Professor: SIEBENTRITT Susanne

Polymer Physics

Modul: Module 2.5 (Semester 2)

ECTS: 4

Objektiv: Polymers, or macromolecules, constitute a fundamental component of modern materials science and technology, they play very important roles in biological systems, and their physics is deeply fascinating. The objective of this course is to introduce students to the underlying physics, and some chemistry, of polymers and the peculiar features that their chain-, ring- or network-like architecture gives rise to. The course will also give an overview of the main experimental techniques that are used to investigate polymer characteristics, as well as of modern application areas of polymers.

Main Objectives

1. To comprehend the concepts monomer, oligomer and polymer, and understand what governs the growth mechanism of polymers.
2. To analyze the possible conformations that polymers of different architecture may adopt, and understand how they link to the micro- and macroscopic physical properties of polymers;
3. To understand how an ensemble of polymer chains behave in a melt, with and without crosslinking, and to apprehend the concept of glass transition and the character of solid polymers;
4. To understand the main experimental techniques used to characterize polymer chains and to account for why polymers are used in particular contexts, in science, technology and everyday life.

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Course learning outcomes:

A student who passes this course will be able to:

- Explain the differences between the two main types of polymer synthesis in terms of maximum chain lengths and polydispersity;
- Discuss the physical behavior of polymers in dependence of their size, chain structure and overall architecture;
- Express the dimension of a single polymer chain in different environments by using entropy and enthalpy argumentation as well as scaling arguments;
- Explain, using thermodynamic arguments, why blending of polymer is challenging;
- Explain qualitatively, in terms of molecular dynamics, the complete range of mechanical properties of polymers, with and without chemical crosslinking, as a function of temperature;
- Know which experimental instruments are available to measure particular properties of polymer chains;
- List at least five contexts where polymers play key roles, among natural and artificial materials, and explain why polymers are the right choice for the desired function.

This course will enable the student to read basic/applied academic literature related to the physics of polymers, linear and in network topology. It also provides a firm basis to follow more advanced courses in soft condensed matter.

Beschreibung:

- Basic concepts of polymer science. Polymer classification, architecture/topology, structural isomerism, size/mass distributions and how to describe and measure them.
- Polymer synthesis: Addition and Condensation reactions. Chemical crosslinking.
- Polymer states of matter (equilibrium and non-equilibrium) in the bulk and in solution.
- Ideal polymer chains and their possible configurations. Persistence length and the Kuhn segment; radius of gyration; the Rouse and reptation models.
- Experimental methods for determining polymer properties.
- Entropy and elasticity of single polymers and polymer networks (rubbers).
- Real polymer chains and their possible configurations
- Thermodynamics of polymer blends and solutions; Flory-Huggins theory.
- Block copolymers, liquid crystal polymers, polymers in textiles, biology and adhesives.

Modalitäten:

Lecture and TD

Sprache:

Anglais

Pflichtkurs:

Oui

Evaluation:

TD, powerpoint presentations, and oral exam

Remark:

Support :

Lecture slides available on Moodle or on the lecturer's teaching website.

Literature :

Introductory physics, readable text:

"Giant Molecules" by Grossberg and Khoklov, World Scientific Press, ISBN-13: 978-9812839220

Physics:

"Polymer Physics" by Rubinstein and Colby, OUP Oxford, ISBN-13: 978-0198520597

Chemistry and some Physics:

"Organic and Physical Chemistry of Polymers" by Gnanou and Fontanille, Wiley, ISBN: 978-0-471-72543-5

Professor:

LAGERWALL Jan

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Lab class

Modul:	Module 2.6 (Semester 2)
ECTS:	6
Objektiv:	The module aims at <ul style="list-style-type: none">• familiarizing the student with modern research topics in experimental and theoretical condensed-matter physics• fostering the student's ability to autonomously achieve scientific tasks• introducing the student to modern experimental techniques and challenging theoretical approaches• strengthening the student's experimental and analytic skills• developing the student's capability to interpret and properly describe scientific results
Course learning outcomes:	A student who passes this course is expected to be able <ul style="list-style-type: none">• to tackle new scientific tasks in experimental and theoretical condensed-matter physics• to familiarize himself with modern experimental tools and challenging theoretical approaches• to work on a modern research topic with a proper autonomy• to work out and defend scientific reports
Beschreibung:	Examples for experiments include: <ul style="list-style-type: none">• Electrochemical and thin film properties of Copper (8 hours)• Opto-electric properties of semiconductors in Schottky barriers (8 hours)• Magnetometry (8 hours)• X-ray diffraction (8 hours)• Rare Event Sampling (8 hours)• Free Energy Estimation (16 hours)• Rheology (16 hours)• Temperature modulated differential scanning calorimetry (16 hours)• Solar cells (16 hours)• Photoluminescence (8 hours)• Raman IR (8 hours)• TEM, SEM (8 hours)• Band-structure calculations of semiconductors (16 hours)• Electric currents in nanojunctions (16 hours)
Modalitäten:	Practical training
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	Written reports on experiments; continuous control
Remark:	Support : Handouts describing topics and tasks and literature references indicated therein Literature : Handouts describing topics and tasks and literature references indicated therein
Professor:	EHRE Florian

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Literature Seminar

Modul:	Module 2.7 (Semester 2)
ECTS:	2
Objektiv:	The course aims at introducing the student to basic topics of condensed-matter physics as well as teaching him/her to read scientific literature, and to present and defend its contents orally.
Course learning outcomes:	A student who passes this course will be able to: <ul style="list-style-type: none">• read and understand the main ideas of a scientific article• present and defend a piece of scientific research to an audience
Beschreibung:	Examples for possible seminar presentations: <ul style="list-style-type: none">• Solution of the 1D Ising model• Capillary waves at gas liquid interfaces• Skyrmion lattices in metallic and semiconducting B20 transition metal compounds• Dynamic nuclear polarization• Graphene and other two-dimensional materials: physical properties and potential technological applications.• Topological insulators: what are they, how do they work, and what is their technological relevance?
Modalitäten:	Seminar
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	Oral presentation (seminar)
Remark:	Support : Scientific articles and references therein Literature : Scientific articles and references therein
Professor:	BARRAGAN YANI Daniel Antonio

Business Game simulation

Modul:	Module 2.8 (Semester 2)
ECTS:	1
Course learning outcomes:	Make the synthesis of all what they learnt during the current academic year.
Beschreibung:	Business Game simulation

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"Cesim Global Challenge is an educational business game simulation that improves learners' understanding of the global business operations of a firm in a dynamic, competitive environment" (Cesim, Global challenge website).

Modalitäten:	Students are working per group and give strategic decision under time constraint. There are 6 to 8 decisions to take in 2 days. At the end of the business game simulation, students present orally their strategic decisions under a reflexive prism.
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	Oral Exam - Examen oral
Remark:	LITERATURE https://www.cesim.com/simulations/cesim-global-challenge-international-business-strategy-simulation-game
Professor:	GERAUDEL Mickaël

Ideation Camp 7th edition

Modul:	Module 2.8 (Semester 2)
ECTS:	3
Objektiv:	During the Ideation Camp, you will acquire crucial transversal skillset helping you succeed in any leadership roles be it as leading entrepreneurs or as promising intrapreneurs in corporate sector. We aim to achieve this goal via exposing you to inspiring speakers, targeting skillset development via educational workshops and finally, helping you learn via tackling unique challenges.
Course learning outcomes:	With a wide breadth of knowledge about entrepreneurship, creativity, innovation and business essentials, the skills learned during this Ideation Camp are vital for the success of any business, both new ventures as well as in established companies. The goal of this 72 hours course is to provide participants guidance with an overarching framework: <ul style="list-style-type: none">· Identify an opportunity or a problem worth solving· Brainstorm and design a creative innovative solution· Evaluate an idea and engage with a wide range of stakeholders· Assess the market· Strategize your venture growth plan· Pinpoint and manage the critical risks· Build a financial model and discover the key financial information· Learn to pitch effectively· Interact effectively with your peers with diverse skills and experience· Network with relevant stakeholders in the entrepreneurship ecosystem in Luxembourg and worldwide
Beschreibung:	The Ideation Camp is a 4-days long workshop in which you will work in cross-disciplinary teams, to tackle challenges, come up with solutions, assess their ideas, launch their ventures, and to pitch their plans in front of investors.

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By participating to this Ideation Camp, you will gather experience in using an inter-disciplinary approach, the capability to brainstorm and think out of the box, and in the generation of ideas.

Modalitäten:	The Ideation Camp consists of a close collaboration with highly motivated teammates, support from renowned actors, experts, entrepreneurs and professionals of the Luxembourgish startup ecosystem who will mentor participants' projects, four inspirational workshops.
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	All students must participate to the full Ideation Camp including workshops, round table, teamworking etc... Each startup team builds a pitch deck and present their startup idea in front of a jury on the last day of the Ideation Camp.
Professor:	BACTAVATCHALOU Sivakumar

Probability (stochastic analysis)

Modul:	Module 2.8 (Semester 2)
ECTS:	5
Objektiv:	Introduction to basic concepts of Stochastic Analysis
Beschreibung:	Continuous martingales, stochastic integration, quadratic variation, Itô calculus, theorem of Girsanov, stochastic differential equations, Markov property of solutions, connection of stochastic differential equations and partial differential equations, martingale representation theorems, chaotic expansions, Feynman-Kac formulas
Modalitäten:	Lecture course
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	Written exam
Remark:	I. Karatzas, S. Shreve: Brownian motion and stochastic calculus. 2nd edition. Springer, 1991 B. Oksendal: Stochastic differential equations. Springer, 2003 D. Revuz, M. Yor: Continuous Martingales and Brownian Motion. Springer Grundlehren, 1999
Professor:	PECCATI Giovanni

Principles of Software Development

Modul:	Module 2.8 (Semester 2)
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ECTS:	5
Objektiv:	<p>The objective of the course is to introduce some principles of software development through the presentation of the Android ecosystem. After successful completion of this course the student should be able to:</p> <ul style="list-style-type: none">- understand the main principles on which Java is based on;- efficiently use software repositories or source code management systems and make the difference between git, svn or cvs <p>- understand the notion of design patterns</p> <p>- implement an Android application and understand the concept of Inter-Component Communications.</p>
Course learning outcomes:	<ul style="list-style-type: none">* design a reusable and evolvable software* successfully conduct a software project* leverage APIs
Beschreibung:	<p>Sessions on Java</p> <p>Session on Design Pattern</p> <p>Session on Software development lifecycle</p> <p>Session on source code management systems</p> <p>Session on Introduction to Android</p> <p>Sessions on Android Interface and Communication (Layout, Android Activity and introduction to the concept of Intent)</p> <p>Sessions on Android Data and Services (Services, Broadcast receiver, and Content Providers)</p> <p>Session for the preparation of the final project</p> <p>Sessions of practical</p>
Modalitäten:	<p>The lessons are combining (formal) presentations and practical exercises.</p> <p>Each student will write code! Bring your laptop.</p>
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	<p>A final written exam will account for 50% of the grade.</p> <p>The remaining 50% are based on a project evaluation focusing on the implementation of an Android Application.</p>
Professor:	KLEIN Jacques, BISSYANDE Tegawendé François d Assise

Knowledge Discovery and Data Mining

Modul:	Module 2.8 (Semester 2)
ECTS:	5

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Objektiv:	We understand Data Mining (Knowledge Discovery) as a life-cycle process from data to information and insights. In times of Big data, Data Mining has become a central interest both for industry and academia. In this course, we discuss several data-related aspects like preprocessing or privacy as well as selected aspects of Machine Learning. An expansive definition of Data Mining, which is the derivation of insights from masses of data by studying and understanding the structure of the constituent data, and selected applications complete the course.
Course learning outcomes:	<ul style="list-style-type: none">* Explain the fundamental concepts of data mining and knowledge discovery* List the properties of data relevant for deriving interesting and useful information/observation from that.* Explain machine learning algorithms and strategies to deploy the discovered results* Argue the importance of domain knowledge during the data analysis with its scope and limitations
Beschreibung:	<ul style="list-style-type: none">* Definition and Process.* Data Mining, Data Science, and the Big Data Hype.* Data Quality and Preprocessing* Data Privacy and Security.* Data and Information Visualization.* Machine Learning for Clustering, Classification, Association Discovery, Sequential Pattern Analysis, and/or Time Series Analysis.
Modalitäten:	The course is organised as a lecture with integrated exercises. It follows the "Information Retrieval" course and will itself be continued in Semester 3 by a more intensive discussion about "Machine Learning". Each participant must be inscribed via Moodle. Course material will be uploaded regularly.
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	60% oral or written examination; 40% midterm tests
Remark:	Selected references: <ul style="list-style-type: none">* M. Berry, G. Linoff: Mastering Data Mining, John Wiley & Sons, 2000.* U. Fayyad, G. Piatetsky-Shapiro, P. Smyth, R. Uthurusamy: Advances in Knowledge Discovery and Data Mining, AAAI/MIT Press, 1996.* J. Han, M. Kamber: Data Mining: Concepts and Techniques, 2nd edition, Morgan Kaufmann, ISBN 1558609016, 2006.* I. Witten, E. Frank, M. Hall: Data Mining: Practical Machine Learning Tools and Techniques, 3rd Edition, Morgan Kaufmann, 2011.
Professor:	SCHOMMER Christoph

Partial Differential Equations II

Modul:	Module 2.8 (Semester 2)
ECTS:	5

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Objektiv:	Learning tools in order to deal with PDE, understanding the interplay between local and global problems and techniques.
Beschreibung:	Distributions as generalized functions continued, Sobolev spaces, elliptic regularity, elliptic operators on compact manifolds, some non-linear equations.
Modalitäten:	Lecture course
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	Written exam
Remark:	1. Jost: Postmodern analysis 2. Folland: Introduction to partial differential equations 3. Reed-Simon: Methods of mathematical physics I-IV 4. Aubin: Nonlinear analysis on manifolds
Professor:	OLBRICH Martin, PALMIROTTA Guendalina

Didactics for Physics 2

Modul:	Module 2.8 (Semester 2)
ECTS:	3
Objektiv:	<ul style="list-style-type: none">• découvrir la richesse de l'enseignement de la physique• planifier et vivre des situations de TP en classe• expérimenter différentes méthodes modernes d'enseignement• analyser ses propres performances pour mieux s'orienter dans son choix professionnel• évaluer la performance des élèves• comprendre l'enseignement de la physique au secondaire et secondaire technique
Course learning outcomes:	Connaître les multiples facettes de l'apprentissage et de l'enseignement de la physique et les défis posés à l'enseignant.
Modalitäten:	cours magistraux, travail indépendant, travaux pratiques, travaux dirigés
Sprache:	Français, Allemand
Pflichtkurs:	Non
Evaluation:	Engagement régulier, élaboration d'un portfolio personnel (pièces créées à partir des éléments traités en cours), présentation du portfolio
Remark:	Notes de cours G. de Vecchi, L'enseignement scientifique, Delagrave, 2002, ISBN: 2-206-08471-6 H. Gudjons, Handlungsorientiert lehren und lernen, Klinkhardt, 2008, 2008, ISBN: 978-3-7815-1625-0

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Kirchner Girwidz Häußler, Physikdidaktik, Springer, 2001, ISBN: 3-540-41936-5
H. Klippert, Methodentraining, Beltz 2005, ISBN: 3-407-62545-6
A.B. Arons Teaching Introductory Physics, Wiley, 1996, ISBN: 978-04711-37078
M. Reiss Understanding Science Lessons, Open University Press, 2001, ISBN:
978-0335-197699
H.K. Mikalsis (Hrsg.) Physik Didaktik, Cornelsen Scriptor, 2006, ISBN: 378-3589221486

Professor: EICHER Carol, MALLINGER Marc

Advanced engineering materials

Modul: Module 2.8 (Semester 2)

ECTS: 4

Objektiv: Knowledge of structural materials (metals as ferrous and nonferrous alloys; ceramics and glasses; polymers, and composites) and their use in the view of a sustainable use of resources.

Course learning outcomes: The students will be capable to understand the different properties of the different key engineering materials and their use.

Beschreibung:

Metals:

- Ferrous alloys (carbon and low-alloy steels, high-alloy steels, cast irons) and recent developments in high-strength steel
- Nonferrous alloys (aluminium alloys, magnesium alloy, titanium alloys, and other alloys)
- Processing of metals and the influence on their properties

Ceramics and glasses:

- Crystalline ceramics
- Glasses
- Glass-ceramics
- Processing of ceramics and glasses and the influence on their properties

Polymers:

- Thermoplastic polymers
- Thermosetting polymers
- Processing of polymers

Composites:

- Fiber-reinforced composites
- Aggregate composites
- Honeycomb structures
- Properties on composites and the property averaging
- Processing of composites

Materials and our environment:

- Environmental aspects of design
- Recycling

Modalitäten: Lectures

Sprache: Anglais

Pflichtkurs: Non

Evaluation: Written Examination



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Professor: USELDINGER Ralph

Academic English B2.2

Modul: Module 2.8 (Semester 2)

ECTS: 2

Sprache: Anglais

Pflichtkurs: Non

Professor: STENKE Jenny

Academic English C1.2

Modul: Module 2.8 (Semester 2)

ECTS: 2

Sprache: Anglais

Pflichtkurs: Non

Professor: HIGGINS Paul



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Semester 3

Lab Class in Preparation for Master Thesis

Modul:	Module 3.1 (Semester 3)
ECTS:	27
Sprache:	Anglais
Pflichtkurs:	Oui
Professor:	MICHELS Andreas

Seminar on the Master Thesis Topic

Modul:	Module 3.1 (Semester 3)
ECTS:	3
Sprache:	Anglais
Pflichtkurs:	Oui
Professor:	MICHELS Andreas



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Semester 4

Master Thesis

Modul:	Module 4.1 (Semester 4)
ECTS:	20
Sprache:	Anglais
Pflichtkurs:	Oui
Professor:	LAGERWALL Jan, SCHMIDT Thomas

Defense of Master Project

Modul:	Module 4.1 (Semester 4)
ECTS:	10
Sprache:	Anglais
Pflichtkurs:	Oui
Professor:	LAGERWALL Jan, SIEBENTRITT Susanne