Institut für Physik

englische Modulbeschreibungen für die Studiengänge

- Master Physik (MSc-Phy)
- Master of Life Light and Matter (MSc-LLM)
- Computational Science and Engineering (MSc-CSE)

zuletzt bearbeitet von: Thomas Fennel

Stand. 8.12.2015

Inhalt

Category	Content
Name (German)	Aktuelle Probleme der Physik
Subtitle	
Name (English)	Current Problems of Physics
Credit points and total work load	6 180 hours
Contact person	Director of the Institute of Physics
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	sporadic

Learning and qualification objectives (competences)	The students become acquainted with experimental and theoretical methods of a special field of modern physics. They acquire basic knowledge in this special field of physics and are aware of important recent developments and open questions. They know relevant advanced models to describe the physical phenomena. The students get familiar with mathematical methods, analytical as well as numerical, to solve typical problems in physics. They know different approximations and are able to assess their advantages and drawbacks. The students are aware of pros and cons of advanced modern experimental techniques and know how these different methods complement each another. The students are able to start experimental or theoretical scientific work.
Course contents	depends on topic
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture Seminar Total	3 SWS 1 SWS 4 SWS
Work load for students	Classes Preparation of classes, studying Solving of excercises Preparation/examination Total work load	56 hrs. 64 hrs. 40 hrs. 20 hrs. 180 hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350270

Category	Content
Name (German)	Analyse der Struktur und Dynamik nanostrukturierter Materialien
Subtitle	
Name (English)	Analysis of Structure and Dynamics of Nanostructured Materials
Credit points and total work load	6 180 hours
Contact person	Prof. Burkel
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students get acquainted with important research methods to characterize the structure and the dynamics of new materials. A special focus is laid on methods for modern nano-technology in materials and life sciences. The students study selected techniques. The students are able to read up on current topics of modern physics in the literature.
Course contents	Research with synchrotron radiation and neutrons at Large Scale Facilities: Sources, instrumentation, spectroscopic methods and scattering techniques with X-rays, neutrons, ions and electrons, imaging methods; microscopy methods; calorimetric techniques; magnetic resonance methods
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	3	SWS
	Seminar	1	SWS
	Total	4	SWS
Work load for students	Classes	56	hrs.
	Preparation of classes, studying	64	hrs.
	Solving of excercises	40	hrs.
	Preparation/examination	20	hrs.
	Total work load	180	hrs.

Prerequisites for the final examination (type and extent)	Presentation
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350300

Category	Content
Name (German)	Atome und Cluster
Subtitle	
Name (English)	Atoms and Clusters
Credit points and total work load	6 180 hours
Contact person	Prof. Meiwes-Broer, Prof. Fennel
Language	English
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students become acquainted with experimental and theoretical methods of atomic and cluster physics. They acquire basic knowledge in this special field of physics and are aware of important recent developments and open questions. They know relevant advanced models to describe the physical phenomena. The students get familiar with mathematical methods, analytical as well as numerical, to solve typical problems in atomic and cluster physics. They know different approximations and are able to assess their advantages and drawbacks. The students are aware of pros and cons of advanced modern experimental techniques and know how these different methods complement each another. The students are able to start experimental or theoretical scientific work in a group working in this field.
Course contents	Atoms: electronic structure, atom-field interactions, QED effects (spontaneous emission), higher-order perturbation theory, magnetic and optical traps, Bose-Einstein condensates, cold fermions, atoms in strong fields, photoionization, generation of high harmonics, inner shell effects, electron correlations Clusters: bonding types, cluster generation, shell models, jellium approximation, electronic structure, fullerenes, nonmetal-metal transition, density-functional theory, polarizability, linear response, sum rules, collective resonances, spectroscopy, optical properties, spin effects, clusters in Helium droplets, on surfaces, in strong fields; nanoplasmas
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	4 SWS
	Seminar	1 SWS
	Total	5 SWS
Work load for students	Classes	70 hrs.
	Preparation of classes, studying	60 hrs.
	Solving of excercises	30 hrs.
	Preparation/examination	20 hrs.
	Total work load	180 hrs.

Prerequisites for the final examination (type and extent)	50 % of achievable points solving exercises
Test performance (type and	Written examination (90 minutes) or oral examination (30 minutes)

extent)	*To be announced in the second week of the lecture period.*

Number	2350310

Category	Content
Name (German)	Berufspraktikum Physik
Subtitle	
Name (English)	Internship Physics
Credit points and total work load	6 180 hours
Contact person	Head of examination board
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Every semester

Learning and qualification objectives (competences)	The students work in an enterprise or institute with the job profile of a physicist. They gain first experience in a real working environment and get confronted with practical project-oriented, organizational, and social situations. The students get experience to prepare for a job application.
Course contents	
Recommended literature	no

Semester periods per week (SWS) by type of course	Total	0 SWS
Work load for students	Internship	160 hrs.
	Preparation/examination	20 hrs.
	Total work load	180 hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Report (2-3 pages)

Number	2350320

Category	Content
Name (German)	Biosystems Modeling and Simulation
Subtitle	
Name (English)	Biosystems Modeling and Simulation
Credit points and total work load	6 180 hours
Contact person	Lehrstuhl für Systembiologie und Bioinformatik
Language	English
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	no
Recommended prerequisites	While this course is an introduction, a basic understanding of mathematical modelling (e.g. Markov processes, differential equations) is recommended. No prior knowledge of biological topics is necessary. The biological and biochemical background is introduced in the lectures.

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	This course is an introduction to the interdisciplinary research field of systems biology; combining systems theory with applications to biological systems. Using experimental data and information from biological databases, systems biology investigates networks of biochemical reactions that are underlying the functioning of living cells and disease mechanisms. This course introduces basic techniques for mathematical modelling and computational simulations of nonlinear dynamic systems. While the mathematics is of a general nature, dealing with basic stochastic and differential equation models of dynamic systems, we introduce applications and case studies from modern life sciences. The course enables to: • formulate models of nonlinear dynamic systems • formulate models of stochastic processes • translate a given (biological) problem into a mathematical representation • analyze the dynamical system properties with various mathematical methods
Course contents	- Biochemical reaction networks - Systems theory - Experimental data generation - Modelling biochemical reactions - Stochastic modeling and simulation - Nonlinear dynamics - Pathway modelling - Dynamic motifs and modules - Feedback, regulation and control - Tools and databases
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	3	SWS
	Exercise	1	SWS
	Total	4	SWS
Work load for students	Classes	55	hrs.
	Preparation of classes, studying	45	hrs.
	Solving of excercises	30	hrs.
	Preparation/examination	50	hrs.

	Total work load 180 hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes)

Number	1150170

Category	Content
Name (German)	Deutsch für internationale Masterstudiengänge A1 GER
Subtitle	
Name (English)	German for International Master's Courses A1 CEFR
Credit points and total work load	6 180 hours
Contact person	Language Centre
Language	German
Admission restriction	none

Level	Language level A1 GER
Mandatory prerequisites	none
Recommended prerequisites	Entry-level test

Duration	1 semester
Term	Every semester

Learning and qualification objectives (competences)	The course enables students to • cope with familiar everyday situations in their university environment appropriately; • reply to questions and ask for/ provide simple information • read simple texts written in standard language and dealing with topics they are familiar with • write simple texts and speak about topics of personal interest they are familiar with and to express their own impressions and opinions Students learn and practise communication strategies such as paraphrasing, inferring the meaning of unknown vocabulary from the context, and learning strategies, such as using a dictionary.
Course contents	Students learn and practise communication strategies such as paraphrasing, inferring the meaning of unknown vocabulary from the context, and learning strategies, such as using a dictionary.
Recommended literature	none

Semester periods per week (SWS) by type of course	Excercise course	8	SWS
	Total	8	SWS
Work load for students	Classes	118	hrs.
	Preparation of classes, studying	56	hrs.
	Preparation/examination	6	hrs.
	Total work load	180	hrs.

Prerequisites for the final examination (type and extent)	Regular attendance (at least 80 % - documented by attendance list)	
Test performance/ requirements for a successful examination (type and extent)	1st Exam:	Written examination (60 - 90 minutes)
	2nd Exam:	Oral examination (15 minutes)

Number	9109090

Category	Content
Name (German)	Einführung in die Atmosphärenphysik und in die Physik des Ozeans
Subtitle	
Name (English)	Introduction to Atmospheric Physics and Ocean Physics
Credit points and total work load	6 180 hours
Contact person	Prof. Dr. F.-J. Lübken (Atmosphärenphysik/ Atmospheric Physics) Dr. V. Mohrholz (Physik des Ozeans/ Ocean Physics)
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students become acquainted with concepts and phenomena in Atmospheric Physics and Ocean Physics. On this basis, they are able to start experimental or theoretical work in a scientific working group in this field. They have an overview of the relevant knowledge in these fields. They are aware of important recent developments. They acquire a basic experimental and theoretical knowledge in these fields, and have therefore the fundament for a profound specialisation.
Course contents	Fundamental physical processes in the atmosphere: Structure of the atmosphere, basic physical concepts and equations, energy balance, creation of layers, depth of penetration of solar radiation, ozone layer, equations of motion. Fundamental physical processes in the ocean: basic concepts, vertical structure Principles of ocean dynamics: equation of motion, reaction to forcing, waves, tides, thermohaline circulation, observational methods.
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	4 SWS
	Excercise course	1 SWS
	Total	5 SWS
Work load for students	Classes	70 hrs.
	Preparation of classes, studying	60 hrs.
	Solving of excercises	30 hrs.
	Preparation/examination	20 hrs.
	Total work load	180 hrs.

Prerequisites for the final examination (type and extent)	Solution of 50 % of the requested exercises
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350190

Category	Content
Name (German)	Foundations of Life, Light and Matter Research
Subtitle	
Name (English)	Foundations of Life, Light and Matter Research
Credit points and total work load	6 180 hours
Contact person	Prof. Dr. S. Speller, Prof. S. Lochbrunner
Language	English
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students become acquainted with the basics of quantum mechanics in atomic, molecular and solid state physics. The know relevant models and approximations for the description of physical phenomena in these fields, and they can apply them. They know important experimental techniques for different physical quantities. They are able to familiarize themselves with advanced topics by using the literature.
Course contents	Quantum physics: wave particle dualism, wave function, Schrödinger equation Atomic physics: hydrogen atom, spin, shell model, periodic system, absorption and emission of light Molekular physics: bindung, rotation, vibration Solid state physics: crystal structure, band model, phonons
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	3 SWS
	Excercise course	2 SWS
	Total	5 SWS
Work load for students	Classes	70 hrs.
	Preparation of classes, studying	50 hrs.
	Solving of excercises	40 hrs.
	Preparation/examination	20 hrs.
	Total work load	180 hrs.

Prerequisites for the final examination (type and extent)	Solution of 50 % of the requested exercises
Test performance/ requirements for a successful examination (type and extent)	Written examination (120 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350560

Category	Content
Name (German)	Fundamentals of Photonics
Subtitle	
Name (English)	Fundamentals of Photonics
Credit points and total work load	9 270 hours
Contact person	Prof. Scheel, Prof. Hage
Language	English
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students have an overview of the relevant knowledge in the field. They are aware of important recent developments and open questions. The students become acquainted with experimental and theoretical methods of the field and their usefulness for particular physical problems. The students are familiar with mathematical techniques necessary to understand these methods. The students know pros and cons of different experimental methods, and how these different methods complement one another. They know relevant models and approximations to describe the physical phenomena. They are aware of the limits of the models.
Course contents	Geometric optics, refraction, reflection, Electromagnetic waves, diffraction, interference, polarisation, coherence, Nonlinear optics, 2nd order and 3rd order nonlinear effects, Field quantisation, quantum states and their properties Transformation optics, metamaterials, Laser physics, Photodetection
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	4 SWS	
	Excercise course	2 SWS	
	Total	6 SWS	
Work load for students	Classes		84 hrs.
	Preparation of classes, studying		96 hrs.
	Solving of excercises		60 hrs.
	Preparation/examination		30 hrs.
	Total work load		270 hrs.

Prerequisites for the final examination (type and extent)	Solution of 50 % of the requested exercises
Test performance/ requirements for a successful examination (type and extent)	Written examination (120 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350350

Category	Content
Name (German)	Grundlagen der Quantenoptik
Subtitle	
Name (English)	Fundamentals of Quantum Optics
Credit points and total work load	6 180 hours
Contact person	Prof. Dr. Vogel, Prof. Dr. Hage
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students have an overview of the relevant knowledge in the field. They are aware of important recent developments and open questions. The students become acquainted with experimental and theoretical methods of the field and their usefulness for particular physical problems. The students are familiar with mathematical techniques necessary to understand these methods. The students know pros and cons of different experimental methods, and how these different methods complement one another. The students become aquianted with a special field of modern physics. On this basis, they are able to start experimental or theoretical work in a scientific working group in this field.
Course contents	quantum optical measurement schemes, phase-space distributions, reconstruction of quantum states;nonclassical properties of light and matter; verification of quantum entanglement and general nonclassical features; probing quantum physics (Bell inequality), quantum cryptography; nonclassical interferometry, quantum optomechanics.
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	3 SWS
	Seminar	1 SWS
	Total	4 SWS
Work load for students	Classes	56 hrs.
	Preparation of classes, studying	64 hrs.
	Solving of excercises	40 hrs.
	Preparation/examination	20 hrs.
	Total work load	180 hrs.

Prerequisites for the final examination (type and extent)	Solution of 50% of the requested exercises
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350360

Category	Content
Name (German)	Halbleiteroptik
Subtitle	
Name (English)	Semiconductor Optics
Credit points and total work load	6 180 hours
Contact person	Prof. Dr. Stolz
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students acquire a deepened understanding of semiconductor physics and optical processes in semiconductors. The know the relevant processes. The are able to solve particular problems in semiconductor optics. The students are able to read up on current topics of modern physics in the literature. The students are able to give a good-quality talk (presentation) on a complex topic of modern physics. They can conduct a scientific discussion.
Course contents	band model; application of group theory in semiconductor physics; phonons, electron-phonon interaction; transport processes; optical processes, excitons, dense electron-hole plasmas, Bose-Einstein condensation; nanostructures, quantum wells, quantum dots; microcavities, polaritons; semiconductor laser
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	2	SWS
	Seminar	2	SWS
	Total	4	SWS
Work load for students	Classes	56	hrs.
	Preparation of classes, studying	64	hrs.
	Solving of excercises	40	hrs.
	Preparation/examination	20	hrs.
	Total work load	180	hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Colloquium (40 minutes)

Number	2350090

Category	Content
Name (German)	Lab Course on Life, Light and Matter Research
Subtitle	
Name (English)	Lab Course on Life, Light and Matter Research
Credit points and total work load	6 180 hours
Contact person	Dr. I. Barke
Language	English
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students acquire knowledge and skills in experimental and theoretical research projects in scientific working groups of the institute of physics. The students are able to read up on the subject in the literature. They apply advanced methods to analyze the results of their measurements or calculations. They can present their findings consisely in a scientific language. They are able to depict complex physical topics in a poster presentation, to conduct the scientific discussion, and to answer questions regarding details.
Course contents	Experimental and theoretical projects from main research areas of the Institute of Physics, the Department of Life, Light, and Matter, and the research group „Bioelectrics“ of the Leibniz-Institut für Plasmaforschung und Technologie Greifswald. Writing lab reports in the style of scientific papers, presentation of one project's results in a poster session.
Recommended literature	no

Semester periods per week (SWS) by type of course	Lab course	4	SWS
	Total	4	SWS
Work load for students	Classes	56	hrs.
	Preparation of classes, studying	94	hrs.
	Preparation/examination	30	hrs.
	Total work load	180	hrs.

Prerequisites for the final examination (type and extent)	Having conducted 5 projects successfully
Test performance/ requirements for a successful examination (type and extent)	Presentation (Poster presentation of one of the projects including discussion)

Number	2350570

Category	Content
Name (German)	Masterarbeit Physics of Life, Light and Matter
Subtitle	
Name (English)	Master Thesis Physics of Life, Light and Matter
Credit points and total work load	30 900 hours
Contact person	Prof. Dr. H. Stolz
Language	English
Admission restriction	none

Level	Master course - specializing
Mandatory prerequisites	Record of at least 72 credit points in the study program.
Recommended prerequisites	none

Duration	1 semester
Term	Every semester

Learning and qualification objectives (competences)	The students get acquainted to a new area of research, they are able to read up on this subject in the literature. They familiarize themselves with measurement methods and are able to master the operation of complex measuring equipment. Or they get acquainted with theoretical concepts and learn to apply scientific computer codes to solve problems numerically. The students work well with others in a team. They are able to discuss complex physical facts and own results referring to the current state of research. They can present this in a scientific work as well as in a talk. In a scientific discussion, they can deal with critical questions and properly present their own results. The students follow the rules of good scientific practice.
Course contents	
Recommended literature	no

Semester periods per week (SWS) by type of course	Consultation	1	SWS
	Total	1	SWS
Work load for students	Classes	14	hrs.
	Preparation/examination	886	hrs.
	Total work load	900	hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	1st Exam: thesis (20 weeks) 2nd Exam: colloquium (40 minutes)

Number	2350580

Category	Content
Name (German)	Molekülphysik
Subtitle	
Name (English)	Molecular Physics
Credit points and total work load	9 270 hours
Contact person	Prof. Lochbrunner, Prof. Kühn
Language	English
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students have an overview of the relevant knowledge in molecular physics. The students become acquainted with experimental and theoretical methods of the field. On this basis, they are able to start experimental or theoretical work in a scientific working group in this field. They are aware of important recent developments in the field and of open questions. The students become acquainted with experimental and theoretical methods of the field and their usefulness for particular physical problems. The students are familiar with mathematical techniques necessary to understand these methods. The students know pros and cons of different experimental methods, and how these different methods complement one another. The students are able to read up on current topics of modern physics in the literature.
Course contents	Fundamentals: Molecular Schrödinger equation, Born-Oppenheimer approximation, potential energy surfaces, non-adiabatic transitions, conical intersections, electron structure theory, bond types, and structure of molecules. Dynamics: Rotation, libration, vibration, normal modes, anharmonicities, wave packet dynamics, system-bath coupling, dissipative dynamics, and rate theories. Elementary processes: Optical excitation, relaxation, dephasing, solvation, chemical reactions, charge transfer, and energy transfer. Systems: Isolated molecules and molecules in solution, biomolecules, supramolecular complexes and aggregates, molecular materials and organic electronics. Experimental techniques: Stationary and time-resolved absorption spectroscopy, fluorescence, infrared and THz spectroscopy, and Raman scattering.
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	4	SWS
	Seminar	1	SWS
	Excercise course	1	SWS
	Total	6	SWS
Work load for students	Classes	84	hrs.
	Preparation of classes, studying	116	hrs.
	Solving of excercises	40	hrs.
	Preparation/examination	30	hrs.
	Total work load	270	hrs.

Prerequisites for the final examination (type and extent)	Presentation
Test performance/ requirements for a successful examination (type and extent)	Written examination (120 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350380

Category	Content
Name (German)	Molecular and Cellular Biophysics
Subtitle	
Name (English)	Molecular and Cellular Biophysics
Credit points and total work load	6 180 hours
Contact person	Prof. Dr. J. Kolb (INP Greifswald), Prof. Dr. S. Speller, Prof. Dr. S. Lochbrunner
Language	English
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students have an overview of the relevant knowledge in biophysics on a molecular and cellular level. The students become acquainted with concepts, methodical aspects and basics models of the field. On this basis, they are able to start an experimental or theoretical master thesis in a scientific working group in this field. They are aware of important recent developments in the field and of open questions. They know relevant models and approximations to describe the physical phenomena in this field. The students become acquainted with experimental techniques of the field and their usefulness for particular physical quantities. The students are able to read up on current topics of modern physics in the literature.
Course contents	Introduction to Biomolecules and Cells - Biomolecules, structure and function: amino acids, proteins, enzymes, nucleic acids, DNA - Central dogma: biosynthesis, transcription, translation - Membranes and transport channels - Structure and organelles of cells - Cellular programs: division, differentiation, repair, apoptosis, cancer - Transport and traffic Electric Properties and Fields - Electrical properties of cell membranes: resting potential, Nernst equation, Goldman-Hodgkin-Katz equation, excitable vs non-excitable cells, Hodgkin-Huxley membrane model - Manipulation of cellular properties and functions by pulsed electric fields, electromagnetic exposures, and non-thermal plasmas, and their application towards diagnostic and treatment of disease Nanoprobing and Biophysical Interactions - NanoProbing methods for biology - Protein layers and specific binding - Aspects of cell-surface contacts Optical Techniques in Biophysics - Microscopy: principles, confocal, multi-photon, super resolution, Raman - Fluorescence and Förster transfer
Recommended literature	none

Semester periods per week	Lecture 3 SWS

(SWS) by type of course	Seminar	1	SWS
	Total	4	SWS
Work load for students	Classes	56	hrs.
	Preparation of classes, studying	64	hrs.
	Solving of excercises	40	hrs.
	Preparation/examination	20	hrs.
	Total work load	180	hrs.

Prerequisites for the final examination (type and extent)	Presentation
Test performance/ requirements for a successful examination (type and extent)	Written examination (120 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350390

Category	Content
Name (German)	Nanotechnologie in der Materialsynthese
Subtitle	
Name (English)	Nanotechnology in Materials Synthesis
Credit points and total work load	6 180 hours
Contact person	Prof. Burkel
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students acquire a deepened knowledge in solid state physics with focus on material science problems. They know relevant nano-techniques to produce new materials. New material's properties are discussed for important applications by the students themselves in seminar contributions. The students know the recent developments and open questions in the field.
Course contents	Material science basics: Phase diagrams, diffusion, mechanical properties, equilibrium and nonequilibrium synthesis methods; Physical and chemical synthesis and structuring methods for new (nano) materials: Layers and layer systems, nanoparticles and nanostructured materials, cluster, lithography, atomic and molecular manipulation; Properties and application of new materials for biomedical and construction technology, regenerative energy economy, Molecular electronics, magnetic materials, materials for fuel cells, heterogenous catalysis and sensors.
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	3	SWS
	Seminar	1	SWS
	Total	4	SWS
Work load for students	Classes	56	hrs.
	Preparation of classes, studying	64	hrs.
	Solving of excercises	40	hrs.
	Preparation/examination	20	hrs.
	Total work load	180	hrs.

Prerequisites for the final examination (type and extent)	Presentation
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes) or oral examination (30 minutes)

Number	2350140

Category	Content
Name (German)	Nature-Inspired Computing
Subtitle	
Name (English)	Nature-Inspired Computing
Credit points and total work load	6 180 hours
Contact person	Prof. Dr. Salomon
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students get an overview of common learning and optimization concepts in nature and biology which are relevant for the development and optimization of technical systems. Thus it is an interesting complement to the classic study course of engineering. Repetition, understanding, application: Realization and application of biologically inspired learning techniques, usage of neuronal networks in technology. Analysis, synthesis: design and functional principles of mobile agents. Evaluation: technical utilization of basic principles of evolutionary optimization. Personal and social skills: autonomy and personal responsibility, project management, cooperation and ability to work in a team, interdisciplinary thinking.
Course contents	design and development of technical systems, particularly their self-X features, may significantly benefit from the incorporation of nature-inspired methods, since they have evolved numerous optimal solutions in nature. This module describes a selection of these methods, and shows how they can be adapted to technical problems. The chosen content will be announced at the beginning of the class as it is influenced by current trends in research and development.
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	2 SWS
	Seminar	1 SWS
	Excercise course	2 SWS
	Total	5 SWS
Work load for students	Classes	70 hrs.
	Preparation of classes, studying	20 hrs.
	Self-study	40 hrs.
	Preparation/examination	50 hrs.
	Total work load	180 hrs.

Prerequisites for the final examination (type and extent)	none	
Test performance/ requirements for a successful examination (type and extent)	1st Exam:	Oral examination (15 minutes)
	2nd Exam:	Project work (40 Stunden)

Number	1351080

Category	Content
Name (German)	Nichtlineare Optik und Spektroskopie
Subtitle	
Name (English)	Nonlinear Optics and Spectroscopy
Credit points and total work load	9 270 hours
Contact person	Prof. Lochbrunner, Prof. Kühn, Prof. Meiwes-Broer
Language	English
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students have an overview of the relevant knowledge in Nonlinear Optics and Spectroscopy. The students become acquainted with experimental and theoretical methods of the field. On this basis, they are able to start experimental or theoretical work in a scientific working group in this field. They are aware of important recent developments in the field and of open questions. The students know relevant models and approximations to describe physical phenomena in the field. The students become acquainted with experimental and theoretical methods of the field and their usefulness for particular physical problems. The students are familiar with mathematical techniques necessary to understand these methods. The students know pros and cons of different experimental methods, and how these different methods complement one another. The students are able to read up on current topics of modern physics in the literature. The students are able to give a good-quality talk (presentation) on a complex topic of modern physics.
Course contents	Fundamentals: Propagation of light in matter, the concept of polarization, electromagnetic transitions, line width, symmetry and selection rules, correlation function, Brownian oscillator model, relaxation and dephasing. Linear Spectroscopy: Absorption, fluorescence, Franck-Condon factors, FTIR spectroscopy, Rayleigh, Raman, and resonance-Raman scattering, photoelectron and mass spectroscopy, molecular beams, and ion traps. Nonlinear light-matter-interaction: Nonlinear polarization, nonlinear susceptibilities, frequency mixing in nonlinear crystals, Kerr effect, self-phase modulation, multiphoton ionization, laser plasma, Coulomb explosion, attosecond pulses, and free electron laser. Nonlinear Spectroscopy: multiphoton, Doppler free, and saturation spectroscopy, response function, four wave mixing, pump-probe spectroscopy, photon-echo and multidimensional spectroscopy, and coherent control.
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	4	SWS
	Seminar	1	SWS
	Excercise course	1	SWS
	Total	6	SWS
Work load for students	Classes	84	hrs.
	Preparation of classes, studying	116	hrs.

	Solving of excercises	40 hrs.
	Preparation/examination	30 hrs.
	Total work load	270 hrs.

Prerequisites for the final examination (type and extent)	50 % of achievable points solving exercises or presentation
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350400

Category	Content
Name (German)	Numerische Methoden der Vielteilchenphysik
Subtitle	
Name (English)	Computational Many-particle Physics
Credit points and total work load	6 180 hours
Contact person	Prof. Dr. D. Bauer, Prof. T. Fennel
Language	German or English (to be announced in the second week)
Admission restriction	no

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students become acquainted with the numerical solution of problems in the field of many-particle physics. They can apply their knowledge to new problems and, on that basis, become qualified to start theoretical scientific work in a group working in this field. They are aware of important recent developments, challenges, and open questions in the field. The students get used to common theoretical methods of many-particle physics. They get introduced to different approximations, get familiar with mathematical techniques necessary to understand them, and know their pros and cons. The students are aware of relevant analytical as well numerical techniques used in this field. The students can assess the numerical effort of different methods, they know the limits of current computer power.
Course contents	Numerical tools: root finding, numerical integration, finite differences, extrapolation of numerical operators, solution of ordinary and partial differential equations (spectral methods, explicit and implicit propagators, iterative methods, convergence and stability analysis), Numerical methods: optimization (Ising model, simulated annealing), stochastic processes (random walk, diffusion, master equations), matrix inversion and eigenvalues (modes, Schrödinger equation, band structure), partial differential equations (initial values and boundary value problems, time-dependent Schrödinger equation, characteristics, multigrid methods), many particle simulation methods (density-functional theory, particle-in-cell, quantum/classical molecular dynamics) Many-particle physics: scattering theory, WKB methods, density matrix, kinetic theory, density functional theory, Kohn-Sham equations, local-density approximation, gradient expansion, exchange and correlation functionals, electronic structure of many-particle systems, time-dependent density-functional theory
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	3	SWS
	Seminar	1	SWS
	Total	4	SWS
Work load for students	Classes	56	hrs.
	Preparation of classes, studying	50	hrs.
	Solving of excercises	54	hrs.
	Preparation/examination	20	hrs.

	Total work load 180 hrs.

Prerequisites for the final examination (type and extent)	Solving 50 % of the excercises, presentation of one solution in the seminar
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350410

Category	Content
Name (German)	Physik und Technologie der Glasfasern
Subtitle	
Name (English)	Physics and Technology of Optical Fibers
Credit points and total work load	6 180 hours
Contact person	Prof. Dr. Mitschke
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	summer

Learning and qualification objectives (competences)	Students become acquainted with a selected topic from experimental physics. In the process they acquire profound knowledge in the applications of optical fibers in optics, laser physics, and communication technology. This enables them to analyze current problems from research and application of this field, and to start their own research in an experimentally working team.
Course contents	Guiding of light and the concept of modes. Dispersion and mechanisms of loss. Optical components for fiber technology. Nonlinear optical processes in fibers; solitons. Technical applications of optical fibers for telecommunications and for data acquisition.
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	2	SWS
	Excercise course	2	SWS
	Total	4	SWS
Work load for students	Classes	56	hrs.
	Preparation of classes, studying	64	hrs.
	Solving of excercises	40	hrs.
	Preparation/examination	20	hrs.
	Total work load	180	hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period*

Number	2350450

Category	Content
Name (German)	Plasma- und Astrophysik
Subtitle	
Name (English)	Plasma Physics and Astrophysics
Credit points and total work load	9 270 hours
Contact person	Prof. Dr. Redmer
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students become acquainted with the basics of plasma physics and astrophysics. On this basis, they are able to start theoretical work in a scientific working group in these fields. The students have an overview of the relevant knowledge and current topics of interest. They know relevant theoretical methods as well as mathematical techniques and numerical procedures to solve problems in these fields. The students can evaluate the numerical effort of different methods, they know the limits of current computer power. They know different approximations and their pros and cons. The students are able to read up on current topics of modern physics in the literature and to give a survey on that.
Course contents	- plasma parameter: charged particle systems, fusion plasmas, astrophysical plasmas, warm dense matter, shock waves, high pressure physics - theory of dense plasmas: plasmas as Fermi systems, screening and correlation effects, effective Schrödinger equation, equation of state, mass action laws for dissociation and ionization - kinetic theory: Boltzmann equation, H theorem, relaxation time approximation, Chapman-Enskog method, transport coefficients, electrical conductivity - basics of density functional theory: Kohn-Sham theory, Hellmann-Feynman theorem, quantum molecular dynamics simulations, equation of state, pair distribution function, Kubo-Greenwood formula, application to warm dense matter - plasma diagnostics and laser-plasma interaction: ionization and scattering processes, dielectric function, dynamic structure factor, Landau damping, free electron lasers, x-ray Thomson scattering, inertial confinement fusion - physics of stars, brown dwarfs and planets: mass-radius relation and Lane-Emden equation, formation scenarios, thermal evolution of planets, gravity data and planetary interiors, extrasolar planets (detection methods and properties)
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	4 SWS
	Seminar	1 SWS
	Excercise course	1 SWS
	Total	6 SWS

Work load for students	Classes	84	hrs.
	Preparation of classes, studying	116	hrs.
	Solving of excercises	40	hrs.
	Preparation/examination	30	hrs.
	Total work load	270	hrs.

Prerequisites for the final examination (type and extent)	50 % of achievable points solving exercises or presentation
Test performance/ requirements for a successful examination (type and extent)	Written examination (120 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350460

Category	Content
Name (German)	Quantenoptik makroskopischer Systeme
Subtitle	
Name (English)	Quantum Optics of Macroscopic Systems
Credit points and total work load	6 180 hours
Contact person	Prof. Scheel, Prof. Hage
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students have an overview of the relevant knowledge in this special field. They are aware of important recent developments in the field and of open questions. The students become acquainted with experimental and theoretical methods of the field. The students know relevant models and approximations to describe physical phenomena in the field. The students become acquainted with experimental and theoretical methods of the field and their usefulness for particular physical problems. The students are familiar with mathematical techniques necessary to understand these methods. The students know pros and cons of different experimental methods, and how these different methods complement one another. On this basis, they are able to start experimental or theoretical work in a scientificworking group in this field.
Course contents	- Electromagnetic field quantisation in linear dielectric media, linear response theory - Propagation of nonclassical light through dielectric media, heat transfer - Coupling of atoms and molecules to medium-assisted fields - Modified spontaneous decay and spinflip lifetimes, Purcell effect, resonators - Quantum optomechanics - Decoherence processes - Dispersion forces (Casimir / Casimir-Polder force, van der Waals interactions) - Quantum reflection
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	3	SWS
	Seminar	1	SWS
	Total	4	SWS
Work load for students	Classes	56	hrs.
	Preparation of classes, studying	64	hrs.
	Solving of excercises	40	hrs.
	Preparation/examination	20	hrs.
	Total work load	180	hrs..

Prerequisites for the final examination (type and extent)	none

Test performance (type and extent)	Written examination (90 minutes) or al examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350480

Category	Content
Name (German)	Simulation Methods of Molecular Biophysics
Subtitle	
Name (English)	Simulation Methods of Molecular Biophysics
Credit points and total work load	3 90 hours
Contact person	Prof. Dr. O. Kühn
Language	English
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students become acquainted with numerical simulations of biological systems om a molecular level. On this basis, they are able to evaluate theoretical models and their results or even to start theoretical work themselves in a scientific working group in this field. The students have an overview of this special field. The students know relevant models and approximations to describe physical phenomena in the field. The students are familiar with mathematical techniques necessary to understand these methods. The students know pros and cons of different numerical techniques, and how these different methods complement one another. The students are able to read up on current topics of modern physics in the literature.
Course contents	Fundamentals: motivation for simulations in the framework of classical mechanics from the Schrödinger equation, potential energy surfaces and force fields, hybrid quantum mechanics/molecular mechanics (QM/MM) methods, equations of motion in statistical ensembles, statistical analysis of simulation data, free energy calculations, reaction mechanisms, path integral and semi-classical approaches for nuclear quantum effects, stochastic techniques. Numerical techniques: integrating equations of motion, data analysis, approaches for efficient treatment of solvated bio-systems, acceleration of rare events, error analysis. Applications: structure and dynamics of proteins, binding energies, transport in membrane proteins.
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	2	SWS
	Seminar	1	SWS
	Total	3	SWS
Work load for students	Classes	42	hrs.
	Preparation of classes, studying	28	hrs.
	Preparation/examination	20	hrs.
	Total work load	90	hrs.

Prerequisites for the final examination (type and extent)	none

Number	2350490

Category	Content
Name (German)	Spezialisierungsmodul
Subtitle	
Name (English)	Method Training
Credit points and total work load	12 360 hours
Contact person	Prof. Dr. H. Stolz
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - specializing
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Every semester

Learning and qualification objectives (competences)	The students are able to familiarize themselves with a new field, especially with relevant methods for measurments, their analysis or theoretical methods and numerical techniques. They are able to read up on this subject matter in the literature. They acquire necessary skills of experimental or theoretical/mathematical practice in this special research area what is a prerequisite for a successfull work on the master thesis in the subsequent semester. The students are able to prepare a presentation on a complex topic of modern physics. They can lead a scientific discussion. They are able to manage a research project and to set up milestones. The students work well with others in a team.
Course contents	Study project on a physics topic of the choosen specialization: research of current publications, literature, theoretical basics, measuring and evaluation methods with respect to master thesis, project planning, presentation
Recommended literature	no

Semester periods per week (SWS) by type of course	Consultation	0,5	SWS
	Total	0,5	SWS
Work load for students	Consultation	7	hrs.
	Self-study	160	hrs.
	Research	163	hrs.
	Preparation/examination	30	hrs.
	Total work load	360	hrs..

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Presentation (Oral or Poster presentation, 20 minutes)

Number	2350040

Category	Content
Name (German)	Surface Science and Nanostructures
Subtitle	
Name (English)	Surface Science and Nanostructures
Credit points and total work load	9 270 hours
Contact person	Prof. Speller, Dr. Barke
Language	English
Admission restriction	no

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students get acquainted with concepts and methods of surface and nano science. They know basic structural, electronic, magnetic and optical properties of low-dimensional systems. They have an overview of experimental techniques to prepare, analyze and manipulate surfaces and nano-structures. The students can draw physical conclusions from experimental data of different techniques or a combination of techniques.
Course contents	1) Surfaces Overview and applications in surface science Structure and morphology Formalisms in real and reciprocal space Electron diffraction Introduction to vacuum physics Preparation of surfaces Diffusion, nucleation and growth Electronic structure Spectroscopy: ensemble methods Surface phonons Magnetism in low dimensions Adsorption of atoms and molecules 2) Nanoprobes Principles of scanning probe microscopy Instruments Tunneling current and scanning tunneling microscopy Topographic and spectroscopic imaging STM: advanced methods Atomic force microscopy and spectroscopy Nano-optical methods 3) Nanoscale objects and lithography Molecular electronics Physical properties of nanosystems Particle sources Lithography Electron-beam methods
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	4	SWS	
	Seminar	1	SWS	
	Excercise course	1	SWS	
	Total	6	SWS	
Work load for students	Classes			84 hrs.
	Preparation of classes, studying			116 hrs.
	Solving of excercises			40 hrs.
	Preparation/examination			30 hrs.
	Total work load			270 hrs.

Prerequisites for the final examination (type and extent)	50 % of achievable points solving exercises or Presentation
Test performance/ requirements for a successful examination (type and extent)	Written examination (120 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350520

Category	Content
Name (German)	Vertiefungsmodul
Subtitle	
Name (English)	In-depth Knowledge Acquisition
Credit points and total work load	12 360 hours
Contact person	Prof. Dr. H. Stolz
Language	German or English (to be announced in the second week)
Admission restriction	no

Level	Master course - specializing
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Every semester

Learning and qualification objectives (competences)	The students are able to familiarize themselves with a new area of knowledge, they are able to read up on this subject matter in the literature. They acquire a deepened knowledge in this special field of research as required for a successfull work on the master thesis in the subsequent semester. The students are able to prepare a presentation on a complex topic of modern physics. They can lead a scientific discussion.
Course contents	Study project on a given topic of the choosen specialization: current research topics, current publications, literature, theoretical basics, presentation
Recommended literature	no

Semester periods per week (SWS) by type of course	Consultation	0,5	SWS
	Total	0,5	SWS
Work load for students	Classes	7	hrs.
	Self-study	160	hrs.
	Research	163	hrs.
	Preparation/examination	30	hrs.
	Total work load	360	hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Presentation (Oral or Poster presentation, 20 minutes)

Number	2350030

Category	Content
Name (German)	Detektoren und Analysemethoden
Subtitle	
Name (English)	Detectors and Methods of Analysis
Credit points and total work load	6 180 hours
Contact person	Priv.-Doz. Dr.Waldi
Language	German or English (to be announced in the second week)
Admission restriction	no

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students get acquainted with experimental techniques and analysis methods used in particle physics and photonics. The students are able to assess their applicability for specific problems. They can handle statistical methods for data analysis.
Course contents	particle detectors: tracking chambers, emulsions, calorimeters, silicon detectors, momentum measurement, energy measurement of photons, historical experiments, reconstruction of scattering and decay events; basics and application of statistical data analysis: statistical inference, maximum-likelihood fit to experimental distributions, fit with constraints, background subtraction, significance of a signal, Monte Carlo simulation.
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	3	SWS
	Seminar	1	SWS
	Total	4	SWS
Work load for students	Classes	56	hrs.
	Preparation of classes, studying	64	hrs.
	Solving of excercises	40	hrs.
	Preparation/examination	20	hrs.
	Total work load	180	hrs..

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes) or oral examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350170

Category	Content
Name (German)	Dynamik der Atmosphäre
Subtitle	
Name (English)	Dynamics of the Atmosphere
Credit points and total work load	3 90 hours
Contact person	Prof. Dr. E. Becker
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students get acquainted with observed phenomena and theoretical principles concerning the dynamics of the atmosphere. The students are able to start experimental or theoretical work in a scientific working group in this field. They acquire a basic knowledge in this special field of physics. They are aware of important recent developments in the field. They have therefore the fundament for a profound specialisation.
Course contents	Conservation laws in fluid physics and equations of motion for the atmosphere, quasi-geostrophic theory and Rossby waves in the atmosphere (especially interaction between wave and background flow, stratospheric warming, Stokes drift, residual circulation), internal gravity waves (especially WKB approximation and momentum deposition, quasi-biennual oscillation, summer-winter pole circulation in the mesosphere)
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	2	SWS	
	Seminar	0,5	SWS	
	Total	2,5	SWS	
Work load for students	Classes			35 hrs.
	Preparation of classes, studying			30 hrs.
	Solving of excercises			15 hrs.
	Preparation/examination			10 hrs.
	Total work load			90 hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Written examination (45 minutes) or oral examination (20 minutes) *To be announced in the second week of the lecture period.*

Number	2350330

Category	Content
Name (German)	Fortgeschrittene Quantentheorie
Subtitle	
Name (English)	Advanced Quantum Theory
Credit points and total work load	9 270 hours
Contact person	Prof. Dr. D. Bauer
Language	German or English (to be announced in the second week)
Admission restriction	no

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students become acquainted with important analytical methods which can be used to solve basic and some advanced problems of quantum physics. The students get familiar with mathematical methods used in the derivation and application of these methods. They have a sound basic knowledge in this field. They are able to read the literature and to understand specialized lectures.
Course contents	Advanced approximation methods (WKB, variational methods, asymptotic expansions, time-dependent); Scattering theory (Born approximation, partial wave decomposition, scattering of identical particles) Many-electron atoms (Hartree-Fock, Thomas-Fermi, density functional theory) General description of many-body systems (space with variable particle number, creation and annihilation operators for fermions and bosons, occupation number representation, quasi particles) Relativistic wave equations (Klein-Gordon, Dirac) Introduction into field theory (field quantization, Noether theorem, Klein-Gordon filed, Dirac field and electromagnetic field, meson, fermion and photon propagators, Feynman graphs)
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	4	SWS
	Excercise course	2	SWS
	Total	6	SWS
Work load for students	Classes	84	hrs.
	Preparation of classes, studying	96	hrs.
	Solving of excercises	60	hrs.
	Preparation/examination	30	hrs.
	Total work load	270	hrs.

Prerequisites for the final examination (type and extent)	solution of 50% of the requested exercises
Test performance (type and extent)	Written examination (120 minutes) or oal examination (30 minutes) *To be announced in the second week of the lecture period.*

Number	2350340

Category	Content
Name (German)	Marine Turbulenz
Subtitle	
Name (English)	Marine Turbulence
Credit points and total work load	3 90 hours
Contact person	PD Dr. L. Umlauf
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students become acquainted with the special field Marine Turbulence. On this basis, they are able to start experimental or theoretical work in a scientific working group in this field. They have an overview of the relevant knowledge in these fields. They are aware of important recent developments.
Course contents	Phenomenology of turbulence, deterministic description (Navier-Stokes equations), statistical description (Reynolds-averaged equations), spectral theory of homogeneous turbulence, turbulence regimes in natural waters, statistical turbulence models, instrumentation.
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	2	SWS
	Seminar	0,5	SWS
	Total	2,5	SWS
Work load for students	Classes	35	hrs.
	Preparation of classes, studying	30	hrs.
	Solving of excercises	15	hrs.
	Preparation/examination	10	hrs.
	Total work load	90	hrs.

Prerequisites for the final examination (type and extent)	solution of 50% of the requested exercises
Test performance/ requirements for a successful examination (type and extent)	Written examination (45 minutes) or oral examination (20 minutes) *To be announced in the second week of the lecture period.*

Number	2350370

Category	Content
Name (German)	Ozeanmodellierung
Subtitle	
Name (English)	Ocean Modeling
Credit points and total work load	3 90 hours
Contact person	Prof. Dr. H. Burchard
Language	German or English (to be announced in the second week)
Admission restriction	no

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students become acquainted with the special field Ocean Modeling. On this basis, they are able to start experimental or theoretical work in a scientific working group in this field. They have an overview of the relevant knowledge in the field. They are aware of important recent developments.
Course contents	Consistence, stability and convergence of numerical methods, discretization methods in time for ordinary differential equations, shallow water equations, shifted grids, implicite and semi-implicite methods for models with free surface, construction principles for numerical ocean models, positive-definite advection methods
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	2	SWS
	Seminar	0,5	SWS
	Total	2,5	SWS
Work load for students	Classes	35	hrs.
	Preparation of classes, studying	30	hrs.
	Solving of excercises	15	hrs.
	Preparation/examination	10	hrs.
	Total work load	90	hrs.

Prerequisites for the final examination (type and extent)	Solution of 50% of the requested exercises
Test performance/ requirements for a successful examination (type and extent)	Written examination (45 minutes) or oral examination (20 minutes) *To be announced in the second week of the lecture period.*

Number	2350420

Category	Content
Name (German)	Physik der Ionosphäre
Subtitle	
Name (English)	Physics of the Ionosphere
Credit points and total work load	3 90 hours
Contact person	Prof. Dr. J. Chau
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students get acquainted with observed phenomena and theoretical principles concerning the physics of the ionosphere. The students are able to start experimental or theoretical work in a scientific working group in this field. They acquire a basic knowledge in this special field of physics. They are aware of important recent developments in the field. They have therefore the fundament for a profound specialisation.
Course contents	Electrodynamics of the Ionosphere, plasma instabilities in the Ionosphere, coupling of the Ionosphere with the lower and middle atmosphere as well as with the Magnetosphere.
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	2	SWS
	Seminar	0,5	SWS
	Total	2,5	SWS
Work load for students	Classes	35	hrs.
	Preparation of classes, studying	30	hrs.
	Solving of excercises	15	hrs.
	Preparation/examination	10	hrs.
	Total work load	90	hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Written examination (45 minutes) or oral examination (20 minutes) *To be announced in the second week of the lecture period.*

Number	2350430

Category	Content
Name (German)	Prozesse im Küstenozean
Subtitle	
Name (English)	Coastal Ocean Processes
Credit points and total work load	3 90 hours
Contact person	Prof. Dr. H. Burchard
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students have an overview of the relevant knowledge in costal oceanography. They are aware of important recent developments in the field. They have an idea how the phenomena in costal oceans can be observed. The students know several analytical methods used in this field.
Course contents	Shallow water equations, boundary layer flows, Ekman dynamics in shallow water, entainment, dense bottom currents, mixed layer, tidal flows, motion of the sea in shallow water, estuarine circulation
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	2	SWS
	Seminar	0,5	SWS
	Total	2,5	SWS
Work load for students	Classes	35	hrs.
	Preparation of classes, studying	30	hrs.
	Solving of excercises	15	hrs.
	Preparation/examination	10	hrs.
	Total work load	90	hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Written examination (45 minutes) or oral examination (20 minutes) *To be announced in the second week of the lecture period*

Number	2350470

Category	Content
Name (German)	Physikalische Chemie VIII: Wasser in den Naturwissenschaften - Struktur, Funktion und Dynamik
Subtitle	
Name (English)	Physical Chemistry VIII: Water in Natural Sciences - Structure, Function and Dynamics
Credit points and total work load	6 180 hours
Contact person	Prof. Dr. Ralf Ludwig, Prof. Dr. Udo Kragl
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	Knowledge on the importance of water in chemistry, biology, and physics. Interdisciplinary understanding of experimental and theoretical methods for the investigation of properties of water in different states of matter, in constrained geometries and at surfaces. Advanced knowledge, problem solving, mastering of methods, interpretation abilility, ability to comment on research problems, presentation skills.
Course contents	Water mythology – anomalies – cluster formation – ice phases – gas hydrates – supercooled water – proton transfer – network defects – aqueous salt solutions – cryoprotectants – proteins/DANN – aquaporines – hydration phenomena – water at interfaces – water splitting – water in space – water models – water analytics – water in technical processes
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	2	SWS
	Seminar	2	SWS
	Total	4	SWS
Work load for students	Classes	56	hrs.
	Preparation of classes, studying	56	hrs.
	Self-study	48	hrs.
	Preparation/examination	20	hrs.
	Total work load	180	hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Written examination (90 minutes) or oral examination (with presentation, 45 minutes) *To be announced in the second week of the lecture period.*

Number	2550270

Category	Content
Name (German)	Spezielle Themen aus der Atmosphärenphysik
Subtitle	
Name (English)	Specific Topics of Atmospheric Physics
Credit points and total work load	3 90 hours
Contact person	Prof. Dr. J. Chau
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - advanced
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students get acquainted with special topic of atmospheric physics. The students are able to start experimental or theoretical work in a scientific working group in this field. They acquire a basic knowledge in this special field of physics. They are aware of important recent developments in the field. The students are familiar with the experimental and theoretical basics of atmospheric physics and have therefore the fundament for a profound specialisation.
Course contents	Ionospherical plasmas, radar methods in atmospheric physics, scattering mechanisms, plasma instabilities, coupling of atmosphere/ionosphere.
Recommended literature	no

Semester periods per week (SWS) by type of course	Lecture	2	SWS	
	Seminar	0,5	SWS	
	Total	2,5	SWS	
Work load for students	Classes			35 hrs.
	Preparation of classes, studying			30 hrs.
	Solving of excercises			15 hrs.
	Preparation/examination			10 hrs.
	Total work load			90 hrs.

Prerequisites for the final examination (type and extent)	none
Test performance/ requirements for a successful examination (type and extent)	Written examination (45 minutes) or oral examination (20 minutes) *To be announced in the second week of the lecture period*

Number	2350500

Category	Content
Name (German)	Standardmodell der Elementarteilchenphysik
Subtitle	
Name (English)	Standard Model of Elementary Particle Physics
Credit points and total work load	9 270 hours
Contact person	Priv.-Doz. Dr. Waldi
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students get acqainted with the interactions between elementary particles and their experimental verification. They know the standard model of particle physics and open problems in this field. They are able to interpret current research results. The students are able to read up on current topics in the literature. They are able to give a high-quality talk (presentation).
Course contents	particles and forces in the Standard Model, interactions of quarks and gluons (QCD), quark model, properties of W and Z bosons, electroweak unification, spontaneous symmetry breaking and Higgs mechanism, quark and neutrino mixing matrix, CP violation, electromagnetic interaction and the structure of nucleons, historical and present experiments and results of particle physics.
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	4 SWS	
	Seminar	1 SWS	
	Excercise course	1 SWS	
	Total	6 SWS	
Work load for students	Classes		84 hrs.
	Preparation of classes, studying		96 hrs.
	Solving of excercises		60 hrs.
	Preparation/examination		30 hrs.
	Total work load		270 hrs.

Prerequisites for the final examination (type and extent)	Oral seminar presentation
Test performance/ requirements for a successful examination (type and extent)	Written examination (120 minutes) or oral examination (45 minutes) *To be announced in the second week of the lecture period*

Number	2350510

Category	Content
Name (German)	Theoretische Ozeanographie I: Grundlagen und Wellenprozesse im rotierenden Ozean
Subtitle	
Name (English)	Theoretical Oceanography I: Basic Principles and Wave Processes in the Rotating Ocean
Credit points and total work load	3 90 hours
Contact person	Dr. M. Schmidt
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Winter

Learning and qualification objectives (competences)	The students get acqainted with the established theoretical methods in the field and are aware of important developments. They are able to apply analytical methods and to interpret current research results. The students are able to read up on current topics in the literature.
Course contents	wind-driven currents, wave processes (gravity waves, inertial waves, planetary waves), dispersion relations, Ekman balance, geostrophic balance, Green's function formalism for the solution of linearized equations of motion.
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	2	SWS	
	Excercise course	0,5	SWS	
	Total	2,5	SWS	
Work load for students	Classes			35 hrs.
	Preparation of classes, studying			30 hrs.
	Solving of excercises			15 hrs.
	Preparation/examination			10 hrs.
	Total work load			90 hrs.

Prerequisites for the final examination (type and extent)	Solution of 50% of the requested exercises
Test performance/ requirements for a successful examination (type and extent)	Written examination (45 minutes) or oral examination (20 minutes) *To be announced in the second week of the lecture period*

Number	2350530

Category	Content
Name (German)	Theoretische Ozeanographie II: Windgetriebene Zirkulation im geschichteten Ozean
Subtitle	
Name (English)	Theoretical Oceanography II: Wind-driven Circulation in the Layered Ocean
Credit points and total work load	3 90 hours
Contact person	Dr. M. Schmidt
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	Theoretische Ozeanographie I

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	Students become acquainted with selected themes of Theoretical Oceanography. From this and embedded in a research group, they are able to start scientific work in this field.They are aware of important recent developments in the field. They have an idea how the phenomena in costal oceans can be observed. The students know several analytical methods and are able to start experimental or theoretical scientific work in a group working in this field.
Course contents	baroclinic processes (upwelling) in eastern boundary currents, development of the balance of equatorial currents, quasi-geostrophic theory, Rossby waves in the ocean, development of subtropic cells (western and eastern boundary currents) Sverdrup balance, balance of the Antartic Circumpolar Current
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	2	SWS
	Excercise course	0,5	SWS
	Total	2,5	SWS
Work load for students	Classes	35	hrs.
	Preparation of classes, studying	30	hrs.
	Solving of excercises	15	hrs.
	Preparation/examination	10	hrs.
	Total work load	90	hrs.

Prerequisites for the final examination (type and extent)	Solution of 50% of the requested exercises
Test performance/ requirements for a successful examination (type and extent)	Written examination (45 minutes) or oral examination (20 minutes) *To be announced in the second week of the lecture period*

Number	2350540

Category	Content
Name (German)	Physik des Klimas
Subtitle	
Name (English)	Physics of Climate
Credit points and total work load	3 90 hours
Contact person	Prof. Dr. E. Becker (IAP)
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students get acqainted with relevant methods and approaches and have advanced knowledge of the physics of the climate. They are aware of important recent developments in the field. The students know several analytical methods and are able to start theoretical scientific work in a group working in this field.
Course contents	radiative transfer in the troposphere and greenhouse effect, boundary-layer theory and surface energy fluxes, moisture budget and convection, radiative-convective equilibrium, simple energy-balance model, Lorenz energy cycle, global energy balance, climate change
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	2	SWS
	Excercise course	0,5	SWS
	Total	2,5	SWS
Work load for students	Classes	35	hrs.
	Preparation of classes, studying	30	hrs.
	Solving of excercises	15	hrs.
	Preparation/examination	10	hrs.
	Total work load	90	hrs.

Prerequisites for the final examination (type and extent)	Solution of 50% of the requested exercises
Test performance/ requirements for a successful examination (type and extent)	Written examination (45 minutes) or oral examination (20 minutes) *To be announced in the second week of the lecture period*

Number	2350440

Category	Content
Name (German)	Weiterführende Konzepte der Atmosphärenphysik
Subtitle	
Name (English)	Advanced Concepts of Atmospheric Physics
Credit points and total work load	3 90 hours
Contact person	Prof. Dr. F.-J. Lübken (IAP)
Language	German or English (to be announced in the second week)
Admission restriction	none

Level	Master course - basic
Mandatory prerequisites	none
Recommended prerequisites	none

Duration	1 semester
Term	Summer

Learning and qualification objectives (competences)	The students are familiar with relevant concepts and phenomena in atmospheric physics. They are aware of important recent developments in the field. Based on their knowledge they are able to start theoretical or experimental scientific work in a group working in this field.
Course contents	Advanced physical processes in the atmosphere, radiative transport, altitude-dependent energy budget, fundamentals of the theory and observation of gravity waves, planetary waves, and turbulence.
Recommended literature	none

Semester periods per week (SWS) by type of course	Lecture	2	SWS	
	Excercise course	0,5	SWS	
	Total	2,5	SWS	
Work load for students	Classes			35 hrs.
	Preparation of classes, studying			30 hrs.
	Solving of excercises			15 hrs.
	Preparation/examination			10 hrs.
	Total work load			90 hrs.

Prerequisites for the final examination (type and extent)	Solution of 50% of the requested exercises
Test performance/ requirements for a successful examination (type and extent)	Written examination (45 minutes) or oral examination (20 minutes) *To be announced in the second week of the lecture period*

Number	2350550