Universität Rostock, Institut für Physik
Module handbook : Master of Science in Physics (international program)

Contents

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Title	Advanced experimental physics + Laboratory work
Code	Basic module 1
Instructors	Professors of Experimental Physics
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 2 SWS Laboratory 2 SWS
Language	English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory module, 1st semester
Specialization/ Successor Modules	All specializations
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	120 240
ECTS Credit Value	12 = 8 + 4
Background assumed	Bachelor degree in physics
Intended Learning Outcomes	Profound knowledge of basic experimental physics.
Content	Atomic physics Molecular physics Solid state physics: crystal structure and diffraction, lattice dynamics, dielectric behavior, magnetism, energy bands,semiconductors, superconductivity Laboratory work: Analog and digital circuit technology, Applications in measurement technology
Preparatory assessment	Certificates for successful tutorial and lab work.
Assessment	Written examination 120 minutes.
Regular Examination Date	1st semester

Title	Advanced theoretical physics + Laboratory work
Code	Basic module 2
Instructors	Professors of Theoretital Physics
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 2 SWS Laboratory 2 SWS
Language	English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory module, 1st semester
Specialization/ Successor Modules	All specializations
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	120 240
ECTS Credit Value	12 = 8 + 4
Background assumed	Bachelor degree in physics
Intended Learning Outcomes	Profound knowledge of basic theoretical physics.
Content	Basic principles of thermodynamics Basic ideas of quantum theory Hydrogen atom and harmonic oscillator Statistical physics, ideal quantum gases Theory of real gases and pair distribution function Special theory of relativity: basic principles, relativistic mechanics Laboratory work: e.g., van der Waals equation, stationary Schrödinger equation
Preparatory assessment	Certificates for successful tutorial and lab work.
Assessment	Written examination 120 minutes.
Regular Examination Date	1st semester

Title	Practical research laboratory I
Code	
Instructors	Professors of Physics, laboratory group
Learning / Teaching Methods	Laboratory work 4 SWS
Language	English or German
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory module, 2nd semester
Specialization/ Successor Modules	All specializations
Duration	one semester
Appointed Semester	Summer semester
Directed Study time (hours) Private Study time (hours)	60 120
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	The students aquire knowledge on research fields of the Rostock working groups. The lab work is research-oriented. Students learn to work in teams and practice scientific writing.
Content	Experiments from the special subject of the different scientific work groups. Excursion to a scientific research center Talk (20 minutes + 15 minutes discussion) on a topic of current interest in connection with the experiments on: Atom force microscopy, BABAR, Thin films, Fourier transform infrared spectroscopy, Semiconductor laser diodes, Helium nano droplets, Calorimetry, Calorimetry in ceramics and metals, Light propagation in glass fibres, LIDAR, Laser induced fluorescence, Pulse propagation in semiconductor films, Raster electron microscopy, Transmission elektron microskope, Measurement of ultra-short pulses, Decay of heavy quarks
Preparatory assessment	6 successfully completed experiments
Assessment	Talk (20 minutes) + 15 minutes discussion
Regular Examination Date	2nd semester

Title	Many-particle theory and numerical methods
Code	11S
Instructors	Professors of Theoretical Physics
Learning / Teaching Methods	Lectures 3 SWS Seminar/Exercise course 2 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 2nd semester
Specialization/ Successor Modules	All specializations
Duration	one semester
Appointed Semester	Summer semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Treatment of many-particle systems. Ability to work autonomously with equilibrium and non-equilibrium models and calculation methods for relaxation processes and tarnsport coefficients. Knowledge of the basics and the implementation of numerical methods.
Content	Theory of phase transitions: equation of state for interacting systems, virial expansion, mean-field approximation, exact solution for one-dimensional systems; Statistical operator fort he non-equilibrium, quantum master equation, linear response theory, Boltzmann equation and solution methods, transport coefficients, correlation functions; Density functional theory: Kohn-Sham equations, local density approximation, gradienten expansion, exchange and correlation functionals, electronic structure of many-particle systems, time-dependent Density functional theory Numerical methods: optimization methods (Ising model, „simulated annealing“), stochastic models („random walk“, diffusion, master equations), matrix inversion and eigenvalues (modes, Schrödinger equation, band structure), partial differential equations (initial and boundary value problems, time-dependent Schrödinger equation, characteristics), Many-particle simulations (density functional theory, „particle-in-cell“ method, (quantum) molecular dynamics)
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	2nd semester

Title	Basics of photonics
Code	12W
Instructors	Professors of specialization « Photonics »
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 2 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 1st semester
Specialization/ Successor Modules	« Photonics (optics and laser physics) » ; « Molecules, clusters and plasmas (particles and fields) » ; « Physics of Atmosphere and Oceans”
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	90 90
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Basic knowledge of photonics enabling the students to handle classical and current applications.
Content	Electromagnetic waves: refraction and reflection, geometric optics. Diffraction, interference: optical instruments. Polarization effects, coherence, Fourier optics, nonlinear optics. Laser physics. Field quantization, quantum states and their properties, Theory of quantum optical measurement.
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	1st semester

Title	Spectroscopy and nonlinear optics
Code	13S
Instructors	Professors of specializations « Photonics » and « Molecules, clusters and plasmas »
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 2nd semester
Specialization/ Successor Modules	« Photonics (optics and laser physics) », « Molecules, clusters and plasmas (particles and fields) », « Physics of Atmosphere and Oceans"
Duration	one semester
Appointed Semester	Summer semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Understanding of the light-matter interaction. Application and development of spectroscopic methods and nonlinear techniques. Analysis of spectroscopic information. Basics of the theoretical description.
Content	Basics: propagation of light in matter, polarization of light, electromagnetic transitions, line width, symmetry and selection rules, correlation functions, Brown oscillator model, relaxation and dephasing Linear spectroscopy: absorption, fluorescence, Franck-Condon factors, FTIR spectroscopy, Rayleigh, Raman and resonance Raman scattering, photo-electrons, mass spectroscopy, NMR Nonlinear light-matter interaction: nonlinear polarization, nonlinear susceptibilities, frequency mixing in nonlinear crystals, Kerr effect, self phase modulation Nonlinear spectroscopy: multi-photon, Doppler-free and saturation spectroscopy, response functions, 4-wave mixing, fs-pump-probe spectroscopy, photon echo and multi-dimensional spectroscopy, coherent control, nonlinear microscopy
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	2nd semester

Title	Quantum optics
Code	14S
Instructors	Professors of specialization « Photonics
Learning / Teaching Methods	Lectures/ Seminar/Exercise course (integrated) 4 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 2nd semester
Specialization/ Successor Modules	« Photonics (optics and laser physics) »
Duration	one semester
Appointed Semester	Summer semester
Directed Study time (hours) Private Study time (hours)	60 120
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Advanced understanding of quantum optics. Understanding of the relevant physical processes. Ability to solve problems in quantum optics.
Content	Basics of the interaction of light and matter, Phase space distributions, Methods to reconstruct quantum states of light and matter. Non-classical properties of light and matter. Properties of entangled quantum states. Detections methods for entanglement. Quantum effects of moving atoms.
Preparatory assessment	Certificate for successful tutorial
Assessment	Talk (20 minutes + 15 minutes discussion)
Regular Examination Date	2nd semester

Title	Semiconductor optics
Code	15W
Instructors	Professors of specialization « Photonics
Learning / Teaching Methods	Lectures/ Seminar/Exercise course (integrated) 4 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 1st semester
Specialization/ Successor Modules	« Photonics (optics and laser physics) », « Nano-technologies and new materials »
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	60 120
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Advanced understanding of semiconductor physics and of optical properties of semiconductors. Understanding of the relevant physical processes. Ability to solve problems in semiconductor optics.
Content	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. Nano-structures, quantum films, quantum dots, micro cavities, polaritons, semiconductor lasers
Preparatory assessment	Certificate for successful tutorial
Assessment	Talk (20 minutes + 15 minutes discussion)
Regular Examination Date	1st semester

Title	Optical fibers
Code	16S
Instructors	Professors of specialization « Photonics
Learning / Teaching Methods	Lectures/ Seminar/Exercise course (integrated) 4 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 2nd semester
Specialization/ Successor Modules	« Photonics (optics and laser physics) », « Physics of Atmosphere and Oceans », « Nano-technologies and new materials »
Duration	one semester
Appointed Semester	Summer semester
Directed Study time (hours) Private Study time (hours)	60 120
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Advanced knowledge of optical fibers applications in optics, laser physics and communication technology. The students are enabled to comprehend current questions in research and application.
Content	Light propagation in fibers, modes Dispersion, loss mechanisms, optical components of optical fiber technology Nonlinear optical processes in fibers, solitons, Technical application in telecommunications and data aquisition.
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	2nd semester

Title	Atoms and clusters
Code	17W
Instructors	Professors of specialization « Molecules, clusters and plasmas »
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 1st semester
Specialization/ Successor Modules	« Molecules, clusters and plasmas (particle and fields) », « Photonics (optics and laser physics) », « Physics of atmosphere and oceans »,
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	The students become aquainted with the theoretical description and experimental investigation methods of atoms and clusters, cold matter in traps as well as atoms and clusters in strong external fields.
Content	Atoms*:* atomic structure, atom-field interaction, magnetica nd optical traps, Bose-Einstein condensates, cold fermions, atoms in strong fields, ionization, high-harmonics generation, particle acceleration with lasers, inner-shell effects, elektron correlations, relativistic laser-atom interaction, QED effects Clusters: bonds, cluster production, shell model, jellium approximation, elektronic structure, fullerens, nonmetal-metal transition, density functional theory, polarizability, linear response theory, sum rules, resonances, spectroscopy, optical properties, spin order, clusters in helium droplets, clusters on surfaces, in strong fields, nanoplasmas
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	1st semester

Title	Physics of molecules
Code	18W
Instructors	Professors of Experimental and of Theoretical Physics
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 1st semester
Specialization/ Successor Modules	All specializations
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Understanding of the molecular structure, of the properties and the dynamics basing on a quantum mechanical description. The students aquire the ability to analyze properties and possible function of molecular constituents.
Content	Basics: molecular Schrödinger equation, Born-Oppenheimer approximation, potential energy surfaces, non-adiabatic transitions, conical transection, elektron structur theory, bindung types and structure of molecules Dynamics: rotation, libration, oscillations, normal modes, anharmonicity, wave packet dynamics, system-bath model, dissipative dynamics, theory of rates Elementary processes: optical excitation, relaxation, dephasing, solvation, chemical reactions, charge transfer, excitation transfer Systems: isolated and dissolved molecules, bio-molecules, supra-molecular complexes and aggregates, molecular materials, molecular electronics
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	1st semester

Title	Plasma physics and astrophysics
Code	19S
Instructors	Professors of Theoretical Physics
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 2nd semester
Specialization/ Successor Modules	« Molecules, clusters and plasmas (particles and fields) »
Duration	one semester
Appointed Semester	Summer semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	The students become aquainted with the theoretical and experimental basics of plasma physics and astrophysics, the classification of plasmas with plasma parameters and basic knowledge of plasma diagnostic methods. Application of statistical physics methods for the theoretical description of plasmas. Genesis, structur and evolution of astrophysical objects like stars and planets.
Content	Plasma parameters: fusion plasmas, astrophysical plasmas, shock wave physics, dusty plasmas, low-temperature plasmas, plasma technology; Dense plasma theory: screening and correlation, equation of state, transport properties, dielectric function, optical properties, quantum molecular dynamics simulations; Laser-plasma interaction: plasma diagnostics, free electron laser, x-rayThomson scattering, inertial confinement fusion; Warm dense matter: structur of stars, brown dwarfs and planets, scenarios of genesis and evolution models.
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	2nd semester

Title	Nanotechnology in the synthesis of materials
Code	20W
Instructors	Professors of specialization « Nanotechnologies and new materials »
Learning / Teaching Methods	Lectures/ Seminar/Exercise course (integrated) 4 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 1st semester
Specialization/ Successor Modules	« Nanotechnologies and new materials »
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	60 120
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Enhanced knowledge in solid state physics with respect to material science problems. The students become aquainted with all important (nano-) technologies in new materials synthesis. They aquire knowledge on the new properties also by preparing own seminar talks on important application.
Content	Basics of materials sciences Phase diagrams, diffusion, mechanical properties Equilibrium and nonequilibrium synthesis Physical and chemical techniques of production and structuring of new (nano-) materials Films and layered systems, nano-particles and nano-structured materials, clusters, lithography, atomic and molecular manipulation Properties and application of new materials for biomedical engineering, design engineering, renewable energy manegement, e.g., molecular electronics, magnetic materials, fuel cells, heterogeneous catalysis, sensors
Preparatory assessment	Successful seminar talk
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	1st semester

Title	Methods to investigate structur and dynamics
Code	21S
Instructors	Professors of specialization « Nanotechnologies and new materials »
Learning / Teaching Methods	Lectures/ Seminar/Exercise course (integrated) 5 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 2nd semester
Specialization/ Successor Modules	« Nanotechnologies and new materials », « Molecules, clusters and plasmas (particles and fields) »
Duration	one semester
Appointed Semester	Summer semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Knowledge of important methods for the charaterization of the structure and the dynamics of new materials with focus on modern nanotechnology in « materials and life schience ». Students become acquainted with selected techniques on their own.
Content	Research with synchrotron radiation and with neutrons at « Large Scale Facilities » Sources, instrumentation, spectroscopy and scattering methods for the analysis of structur and dynamics of nuclei, ions, electrons and moleculs, imaging techniques microscopy methods Light and raster microscopy Calorimetric methods Magnetic resonance method
Preparatory assessment	Successful seminar talk
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	2nd semester

Title	Surfaces and nanostructures
Code	22W
Instructors	Professors of specializations « Nanotechnologies and new materials » and « Molecules, clusters and plasmas »
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 1st semester
Specialization/ Successor Modules	« Nanotechnologies and new materials », « Molecules, clusters and plasmas (particles and fields) »
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Basic knowledge and advanced physical understanding of solid body surfaces, the change of electronic, optical and magnetic properties at the transition to one dimension (nano wires) and zero dimensions (quantum dots, also metallic). Knowledge of experimental methods for the preparation and the analysis of surfaces and nanostructures.
Content	Theoretical basics of surface physics: potential models, structures and symmetries. Adsorption of atoma and molecules on solid-body surfaces: chemisorption, physisorption and diffusion. Experimental methods of surface physics: angle-resolved photoemission, inverse photo-electron spectroscopy, LEED, Auger electron spectroscopy, raster tunnel and atomic force microscopy, Thin metallic films: growth, epitaxy, surface and thin-layer magnetism. Elektric conductivity in systems of reduced . Quantum effects in nanostructures: theoretical background, impact on electronic and optical properties, size effects in the 1-nanometer range. Generation of nanostructures by physical methods and by self-organization. Technical applications.
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	1st semester

Title	Detectors and methods of analysis
Code	23W
Instructors	Professors of the « elementary particle physics » group and the specialization « Photonics »
Learning / Teaching Methods	Lectures 3 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 1st semester
Specialization/ Successor Modules	« Molecules, clusters and plasmas (particle and fields) », « Photonics (optics and laser physics) »
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	60 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Understanding of experimental techniques and methods of analysis in elementary particle physics and in photonics. The students are able to apply statistical methods of data analysis.
Content	Particle detectors: tracker, emulsions, calorimeter, semiconductor detectors, momentum measurement, energy measurement of photons, historic experiments, reconstruction of scattering and decay events. Statistical methods of analysis: statistical inference, maximum likelihood fit to experimental distributions, fit with constraints, background subtraction, Significance of a signal, Monte Carlo simulation.
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	1st semester

Title	Standard model of elementary particle physics
Code	24S
Instructors	Professors of the « elementary particle physics » working group
Learning / Teaching Methods	Lectures 3 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 2ndt semester
Specialization/ Successor Modules	« Molecules, clusters and plasmas (particles and fields) »
Duration	one semester
Appointed Semester	Summer semester
Directed Study time (hours) Private Study time (hours)	60 120
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Understanding of the interactions between elementary particles and their experimental verification. The students are able to interpret current research results of particle physics.
Content	Particles and forces within the standard model, elektromagnetic interaction and the structure of nucleons, interaction of quarks and gluons (QCD), properties of W and Z bosons, electroweak unification, spontaneous symmetry breaking and Higgs mechanism, quark and neutrino mixing matrix, CP violation, current experiments and results of particle physics.
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	2nd semester

Title	Introduction into atmospheric physics and ocean physics
Code	25W
Instructors	Professors of the Institutes for Physics of the Atmosphere (IAP) and for Baltic Sea Research (IOW)
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 1st semester
Specialization/ Successor Modules	« Physics of the atmosphere and oceans »
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Insight into the concepts and phenomena of the physics of the atmosphere. Insight into general problems and concepts of physical oceanography.
Content	Fundamental physical processes in the atmosphere: structur of the atmosphere, basic physical concepts, radiation, energy balance Fundamental physical processes in the ocean: basic concepts, vertical structur, reactions of the ocean to (radiative) forcing Principles of the ocean dynamics: equation of motion, waves, geostrophic adjustment
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	1st semester

Title	Dynamics of the atmosphere and special issues of atmospheric physics
Code	25W
Instructors	Professors of the Institute for Physics of the Atmosphere (IAP)
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 1st semester
Specialization/ Successor Modules	« Physics of the atmosphere and oceans »
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Insight into the dynamics of the atmosphere and special phenomena of atmospheric physics.
Content	Equations of motion, quasi-geostrophic theory, Rossby waves, wave-mean flow interaction, residual circulation, internal gravity waves Special physical processes in the atmosphere like, e.g., aerosol and cloud physics, plasma physics, instabilities, etc.
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	1st semester

Title	Theoretical oceanography and special issues of oceanography
Code	27W
Instructors	Professors of the for Baltic Sea Research (IOW)
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 1st semester
Specialization/ Successor Modules	« Physics of the atmosphere and oceans »
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Insight into special phenomena of oceanography.
Content	Theoretical explanation of the dynamics of oceans and seas, reactions of the ocean to atmospheric forcing Dynamics of oceans and marginal seas, in different climatic zones, water balances and circulation patterns.
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	1st semester

Title	Physics of climate and oceanography
Code	28S
Instructors	Professors of the Institutes for Physics of the Atmosphere (IAP) and for Baltic Sea Research (IOW)
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 2nd semester
Specialization/ Successor Modules	« Physics of the atmosphere and oceans »
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Insight into climate physics. Insight into special phenomena and problems of ocean physics.
Content	Radiation transfer, boundary layer, humidity and convection, Lorenz cycle, climate models, global energy balance, climate change Special aspects of oceanography : coastal upwelling, dynamics of river plumes, measuring methods, etc. Dynamical equilibria and wave processes
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	2nd semester

Title	Dynamics of the atmosphere II and special issues of atmospheric physics
Code	29S
Instructors	Professors of the Institute for Physics of the Atmosphere (IAP)
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 2nd semester
Specialization/ Successor Modules	« Physics of the atmosphere and oceans »
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Broader knowledge of basic atmospheric physics and special phenomena.
Content	Extended basics of atmospheric physics: physics of the ionosphere and of the magnetosphere, photo chemistry, thermodynamics etc. Special aspects: space weather, measuring methods, mixing processes, etc.
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	2nd semester

Title	Numerical models of theoretical oceanography and special issues of oceanography
Code	30S
Instructors	Professors of the Institute for Baltic Sea Research (IOW)
Learning / Teaching Methods	Lectures 4 SWS Seminar/Exercise course 1 SWS
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory elective module, 2nd semester
Specialization/ Successor Modules	« Physics of the atmosphere and oceans »
Duration	one semester
Appointed Semester	Winter semester
Directed Study time (hours) Private Study time (hours)	75 105
ECTS Credit Value	6
Background assumed	
Intended Learning Outcomes	Insight into special phenomena of oceanography.
Content	Processes and methods important in special subjects of oceanography. Numerical models of ocean circulation, marine turbulence
Preparatory assessment	Certificate for successful tutorial
Assessment	Written examination 90 minutes or oral examination 30 minutes
Regular Examination Date	2nd semester

Title	Master thesis
Code	
Instructors	Professors of Physics
Learning / Teaching Methods	Guidance to scientific work in a scientific work group, full-time.
Language	German or English
Branch of Study/ Group of Participants	Master of Science in Physics
Categorie / Position in curriculum	Compulsory module, 4th semester
Specialization/ Successor Modules	All specializations
Duration	one semester
Appointed Semester	Summer semester
Directed Study time (hours) Private Study time (hours)	 900 h
ECTS Credit Value	30
Background assumed	Modules of the 1st, 2nd and 3rd semester.
Intended Learning Outcomes	The students practice scientific working on their own. Documentation of the scientific results in written form. Concise oral presentation of the own work.
Content	Scientific research and development project, respectively. Preparation and execution of scientific investigations. Analysis and editing of the results. Written presentation in form of a scientific paper, i.e., the master thesis.
Preparatory assessment	
Assessment	Master thesis and colloqium.
Regular Examination Date	4th semester