Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Index

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Advanced Hadron and Nuclear Physics**	**6 CP**
Module description	**Advanced Hadron and Nuclear Physics**	
Module code	**MP-01**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • gain an insight into current topics in hadronic and nuclear physics; • gain an insight into modern experimental technology in hadronic and nuclear physics.	
Module content	Hadronic physics with lepton and photon beams, hadronic physics with e^+-e^- colliders and with antiproton beams, form factors, deep inelastic lepton scattering, spin structure of nucleons, exotic hadrons, selected aspects of non-perturbative QCD, ultra-relativistic heavy ion physics, quark-gloun plasma, astro-physical aspects of heavy ion physics.	
Form(s) of instruction	• Lecture (4 hours/week) • Tutorials (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 weeks x 4 hours 60 hours Preparation/revision 45 hours Tutorials: Contact hours 15 weeks x 1 hour 15 hours Revision and homework 45 hours Preparation for examination 13 hours Examination 2 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	50% of maximum possible mark for homework: 25% 50% of written examination: 75%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	60/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Advanced Quantum Mechanics**	**6 CP**
Module description	**Advanced Quantum Mechanics**	
Module code	**MP-02**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	• Deepening of mathematical foundations in advanced quantum mechanics of multi-particle systems; • Insight into the symmetries of multi-particle states and how to deal with these mathematically; • Simple approximations based on the Hartree-Fock method; • Insight into the formulation and solution of multi-particle scattering problems; • Fundamental equations for relativistic Bose and Fermi systems.	
Module content	1. Mathematical fundamentals of theoretical physics; product spaces, residue calculus, general unitary transformations in Hilbert spaces, distributions. 2. Formal structure of quantum mechanics; Bose and Fermi exchange symmetries; representation of particles in multi-particle systems; general formulation of scattering theory; Hartree-Fock methods; Klein-Gordon and Dirac equations; simple examples of relativistic self-energy; Lorentz covariant formulation of the dynamics of general relativistic systems.	
Form(s) of instruction	• Lecture (4 hours/week) • Tutorial (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 4 hours 60 hours Revision 45 hours Tutorial: Contact hours 15 x 1 hour 15 hours Homework 15 x 3 hours 45 hours Examinations: Preparation for examination 12 hours 1 Examination 3 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	1 written examination: 75% 50% of tutorial and homework problems successfully solved: 25%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	60/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Seminar on Experimental Subatomic Physics**	**6 CP**
Module description	**Seminar on Experimental Subatomic Physics**	
Module code	**MP-03 A**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiarised with current topics within hadronic, nuclear and particle physics through the preparation of presentations based on original literature; • learn a convincing presentation style and the use of up-to-date presentation media.	
Module content	Structure of nucleons, meson productions, quark structure of hadrons, hadron spectroscopy, physics of e^+e^- colliders, CP violation, neutrino physics, physics of LHC, ultra-relativistic heavy ion reactions, generation of radioactive radiation, structure of exotic nuclei, nuclear astrophysics, mass spectrometry.	
Form(s) of instruction	Seminar (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Seminar: Contact hours 15 x 2 hours 30 hours Revision 45 hours Preparation of a presentation: Contact hours 5 x 3 hours 15 hours Preparation: Research for presentation topic 30 hours Development of presentation topic 30 hours Drafting of finalised presentation 30 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Successful preparation and delivery of a presentation: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Seminar on Experimental Atomic Physics**	**6 CP**
Module description	**Seminar on Experimental Atomic Physics**	
Module code	**MP-03 B**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • further develop their ability to work a physics topic from the literature into a presentation and deliver this in a clear manner using appropriate presentation techniques; • gain an overview of modern topics in atomic physics.	
Module content	Selected current research topic in modern atomic physics.	
Form(s) of instruction	Seminar (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Seminar: Contact hours 15 x 2 hours 30 hours Revision 45 hours Preparation of a presentation: Contact hours 5 x 3 hours 15 hours Preparation: Research for presentation topic 30 hours Development of presentation topic 30 hours Drafting of finalised presentation 30 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Presentation on a specialised topic covered within the seminar: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Seminar on Solid State Physics**	**6 CP**
Module description	**Seminar on Solid State Physics**	
Module code	**MP-03 C**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiarised with current topics in solid state physics and Advanced Materials through the preparation of presentations based on original literature; • practice a convincing presentation style and using up-to-date presentation media.	
Module content	Production and characteristics of solids, of micro-structures and nano-structures, micro-structuring and nano-structuring, solid state analysis, components	
Form(s) of instruction	Seminar (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Seminar: Contact hours 15 x 2 hours 30 hours Revision 45 hours Preparation of a presentation: Contact hours 5 x 3 hours 15 hours Preparation: Research for presentation topic 30 hours Development of presentation topic 30 hours Drafting of finalised presentation 30 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Successful preparation and delivery of a presentation: 100%	
Frequency, duration	Winter semester, summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Seminar on Applied Physics**	**6 CP**
Module description	**Seminar on Applied Physics**	
Module code	**MP-03 D**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiarised with current topics in applied physics through the preparation of presentations based on original literature; • master a convincing presentation style as well as the use of up-to-date presentation media.	
Module content	• Properties and characteristics of electronic components – preparation and structuring • Solid state, in particular surface and interface physical characterisation	
Form(s) of instruction	Seminar (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Seminar: Contact hours 15 x 2 hours 30 hours Revision 45 hours Preparation of a presentation: Contact hours 5 x 3 hours 15 hours Preparation: Research for presentation topic 30 hours Development of presentation topic 30 hours Drafting of finalised presentation 30 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Successful preparation and delivery of a presentation: 100%	
Frequency, duration	Winter semester, summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Seminar on Theoretical Nuclear and Hadron Physics**	**6 CP**
Module description	**Seminar on Theoretical Nuclear and Hadron Physics**	
Module code	**MP-03 E**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • further strengthen their ability to develop a hadronic physics topic from the literature into a presentation and deliver this in a clear manner using up-to-date presentation techniques; • gain an overview of current topics in hadronic and nuclear physics.	
Module content	• Selected current research topics in modern nuclear and hadronic physics	
Form(s) of instruction	Seminar (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Seminar: Contact hours 15 x 2 hours 30 hours Revision 45 hours Preparation of a presentation: Contact hours 5 x 3 hours 15 hours Preparation: Research for presentation topic 30 hours Development of presentation topic 30 hours Drafting of finalised presentation 30 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Presentation on a specialised topic covered within the seminar: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Seminar on Theoretical Solid State Physics**	**6 CP**
Module description	**Seminar on Theoretical Solid State Physics**	
Module code	**MP-03 F**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall learn to work on a clearly defined area of current research in the field of theoretical solid state physics and to competently present this topic.	
Module content	Selected current research topics in modern advanced materials.	
Form(s) of instruction	Seminar (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Seminar: Contact hours 15 x 2 hours 30 hours Revision 45 hours Preparation of a presentation: Contact hours 5 x 3 hours 15 hours Preparation: Research for presentation topic 30 hours Development of presentation topic 30 hours Drafting of finalised presentation 30 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Presentation on a specialised topic covered within the seminar: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Laboratory Exercises in Physics of Atoms and Quanta**	**6 CP**
Module description	**Laboratory Exercises in Physics of Atoms and Quanta**	
Module code	**MP-04**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall develop the ability to: 1) work on topics concerning the physics of atomic particles and quanta – based on the current literature – and determine how they interact with matter as well as aspects of the resulting practical applications; 2) find solutions to problems by conducting advanced experiments using suitable techniques; 3) appropriately document a research question, the experimental approach, the measurements taken and results, as well as the conclusions.	
Module content	• Radiation detectors and spectroscopy techniques • Fundamental interactions of radiation with matter • Experimental determination of quantities that are important for the atomic shell and atomic nucleus • Use of accelerator orientated measuring techniques • Data processing and data analysis using computers • Scientific presentation on research results	
Experiments	Detection, interaction and spectroscopy of electrons, ions and photons, Moessbauer effect, lifetime measurement with coincidence methods, methods of mass spectrometry, rapid coincidences and running-time measurements.	
Form(s) of instruction	Laboratory (40 hours)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Laboratory: 5 x 8 hours — 40 hours Preparation for laboratory: 5 x 8 hours — 40 hours Contact hours for instruction on lab basics and how to carry out experiments: 5 x 2 hours — 10 hours Conducting experiments: — 70 hours Preparation for final colloquium: — 19 hours Final colloquium: — 1 hour Total — 180 hours	
Examination requirements	Conducting 5 experiments with report on the report on measurement tasks used.	
Form(s) of examination and contribution to final mark	Experiments and reports: 75% Final colloquium: 25%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	20/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Introduction to Nuclear Astrophysics**	**6 CP**
Module description	**Introduction to Nuclear Astrophysics**	
Module code	**MP-05**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall understand and be able to apply knowledge of the following to specific problems: • Fundamentals of astrophysics in relation to star development; • Nuclear processes in stellar energy generation and element synthesis; • Principles of the general relativity theory.	
Module content	• Theory of nuclear reactions and nuclear networks for solar power generation and element synthesis • Principles of the general theory of relativity • Equation of state and star development • Thermodynamics in a stellar equilibrium • Field theoretical models for white dwarfs and neutron stars • Chandrasekhar conditions and TOV equations	
Form(s) of instruction	Lecture (4 hours/week) Tutorials for the lecture (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 4 hours 60 hours Revision 45 hours Tutorials: Contact hours 15 x 1 hour 15 hours Homework 15 x 3 hours 45 hours Examination: Preparation 13 hours 1 Examination 2 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Written examination: 75% 50% of tutorial and homework problems successfully solved: 25%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Introduction to Technical Physics**	**6 CP**
Module description	**Introduction to Technical Physics**	
Module code	**MP-06**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • master the fundamental concepts and methods of technical physics that are necessary for the use of complex experimental equipment; • learn about current technology through field trips to leading industrial firms and research centres.	
Module content	• Macroscopic material properties • Composite materials and technical glass materials • Vacuum technology up to UHV • Heat and refrigeration technology • Light technology and optical instruments, signal processing	
Form(s) of instruction	Lecture (2 hours/week) Tutorial (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 weeks x 2 semester hours 30 hours Preparation/revision 15 weeks x 4 semester hours 60 hours Tutorials and field trips: Contact hours 15 weeks x 1 semester hour 15 hours Preparation/revision 15 weeks x 2 semester hours 30 hours Examination: Preparation 13 hours Examination 2 hours Total 180 hours	
Examination		
Form(s) of examination and contribution to final mark	1 written examination: 100%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Advanced Particle Physics**	**6 CP**
Module description	**Advanced Particle Physics**	
Module code	**MP-07**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiarised with current problems in and methods of modern particle physics.	
Module content	Physics of the standard model, physics beyond the standard model, Higgs mechanism, experiments on the LHC, linear collider, neutrino oscillations, CP violation, super B factories, dark matter, super symmetry, current experiments in particle astrophysics.	
Form(s) of instruction	Lecture (4 hours/week) Tutorials (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 4 hours 60 hours Preparation/revision 45 hours Tutorials: Contact hours 15 x 1 hour 15 hours Revision and homework 45 hours Examination: Preparation 13 hours Examination 2 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	50% of the maximum possible mark on homework: 25% 50% of written examination: 75%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Module	**Laboratory Exercises in Nuclear Physics**	**6 CP**
Module description	**Laboratory Exercises in Nuclear Physics**	
Module code	**MP-08**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	None	
Module guidance	Cf. German Version	
Learning outcomes	Student shall: • undertake fundamental experiments in the field of nuclear physics; • learn the handling of radioactive radiation, detectors, and systems for data acquisition; • be familiarised with statistical methods for the analysis of nuclear physics data.	
Module content	• Introduction to measurement technology in the field of nuclear physics • Experiments on beta radiation • Spectroscopy with semi-conductor detectors • Neutron activation analysis • Mössbauer effect • Gamma-gamma angle correlation • Lifetime measurements	
Form(s) of instruction	Block laboratory (4 weeks)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Laboratory: Contact hours 5 x 8 hours 40 hours Preparation 5 x 8 hours 40 hours Contact hours for instruction on lab basics and undertaking of experiments: 5 x 2 hours 10 hours Conducting experiments: 70 hours Preparation for final colloquium: 19 hours Final colloquium: 1 hour Total 180 hours	
Examination requirements	Undertaking of 5 experiments with report on the conducted measurement tasks.	
Form(s) of examination and contribution to final mark	Experiments and reports: 75% Final colloquium: 25%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Quantum Field Theory**	**6 CP**
Module description	**Quantum Field Theory**	
Module code	**MP-09**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	Advanced Quantum Mechanics	
Module guidance	Cf. German Version	
Learning outcomes	More advanced study of the mathematical fundamentals of field theory and group theory; understanding of irreducible representations of simple groups and of the constituent quark model; learning of the interaction of global and local calibration invariance with conserved quantum numbers and calibration fields; introduction to quantum chromo dynamics and structure of elementary excitations and disintegrations.	
Module content	1. Klein-Gordon and Dirac equations for relativistic fields; Poincare invariance of physical systems, laws of conservation; theory of simple groups and irreducible representations; local calibration invariance and calibration fields, introduction to quantum chromo dynamics. 2. Constituent quark model; dynamic symmetry refraction; chiral invariance; chiral perturbation theory and the interaction of hadrons at low energies; renormalisation of masses and couplings; excitation and disintegration of hadrons.	
Form(s) of instruction	Lecture (4 hours/week) Tutorial (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 4 hours — 60 hours Revision 15 x 3 hours — 45 hours Examination preparation — 12 hours Examination — 3 hours Tutorial: Contact hours 15 x 1 hour — 15 hours Homework 15 x 3 hours — 60 hours Total — 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	50% of tutorial and homework problems successfully solved: 25% 1 written examination: 75%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	60/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Exercises in Computational Physics**	**6 CP**
Module description	**Exercises in Computational Physics**	
Module code	**MP-10**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • develop the ability to solve dynamic and static physics problems with numerical algorithms; • be able to adequately present numerical results.	
Module content	• Integration and differentiation on finite numerical lattices • Coordinate transformation on compact intervals and Monte-Carlo integration • Solutions of coupled differential equations of the first and second order in time • Solving of integral equations using iteration • Inversion of large matrices • Eigenvalue problems of quantum mechanics	
Form(s) of instruction	Practical tutorials with seminar (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Seminar: Contact hours 15 x 2 hours 30 hours Revision 15 x 2 hours 30 hours Solving of a numerical problem Contact hours 5 x 2 hours 10 hours Preparation Research related to topic of the numerical problem 30 hours Working with computational techniques 60 hours Drafting of final presentation 20 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Presentation of the numerical problem worked on during the module: 100%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	20/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Lecture: Experimental Techniques of Nuclear and Particle Physics**	**6 CP**
Module description	**Lecture: Experimental Techniques of Nuclear and Particle Physics**	
Module code	**MP-11**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiarised with the fundamental measuring techniques of modern nuclear physics; • understand the most up-to-date methods for conducting experiments in the fields of nuclear and particle physics.	
Module content	Electromagnetic and hadronic calorimeter, tracking in a magnetic field, multi-wire proportional chambers, drift chambers, TPC, Cherenkov detectors, silicon pixel detectors, transition radiation, data collection systems, trigger systems, simulation systems (GEANT), fundamental methods of data analysis.	
Form(s) of instruction	Lecture (3 hours/week) Tutorials (1 hour/week) Computer simulation (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture 15 x 3 hours: 45 hours Tutorials 15 x 1 hour: 15 hours Preparation/revision (1 hour per contact hour): 80 hours Contact hours: practice at the computer: 30 hours Examination preparation: 8 hours Examination: 2 hours Total: 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	50% of homework problems successfully solved: 25% 50% of written examination: 75%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Semiconductor Physics I**	**6 CP**
Module description	**Semiconductor Physics I**	
Module code	**MP-13**	
Faculty/Subject/Department	Faculty 07/Physics/1st Physics Department	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiar with the fundamental properties of semi-conductor materials; • be familiar with the concepts of modern semi-conductor physics; • understand the particular effects in low-dimensional semi-conductors and the influence on material properties; • be able to translate the fundamentals of semi-conductor physics into applications; • use the acquired knowledge to solve tutorial problem sets.	
Module content	• Manufacturing techniques for semi-conductor structures • Crystal structures of semi-conductors • Band structure models, electronic and phononic structures in different dimensions (0D, 1D, 2D, 3D) • Defects • Methods for the analysis of electronic, phononic, and defect structures	
Form(s) of instruction	Lecture (3 hours/week) Tutorials (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 3 hours 45 hours Revision 45 hours Tutorials: Contact hours 15 x 1 hour 15 hours Preparation/revision 15 x 3 hours 45 hours Examination: Preparation 28 hours Examination 2 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	50% of homework problems successfully solved: 25% Written examination (minimum pass mark: 50%): 75%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Semiconductor Physics II**	**6 CP**
Module description	**Semiconductor Physics II**	
Module code	**MP-14**	
Faculty/Subject/Department	Faculty 07/Physics/1st Physics Department	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • deepen their understanding of modern semi-conductor physics; • understand the particular effects in low-dimensional semi-conductors and be familiar with the influence on optical phenomena and transport processes; • understand fundamental semi-conductor components and be aware of how they can be applied; • prove that they have assimilated class material by successfully completing tutorial problem sets and giving a presentation in seminar.	
Module content	• Semi-conductor statistics • Transport processes in semi-conductor structures • Optical processes in semi-conductor structures • Device concepts, design rules • Unipolar and bipolar devices • Concepts for light-emitting diodes, lasers, photo detectors, solar cells • Optical networks	
Form(s) of instruction	Lecture (3 hours/week) Tutorials and seminar (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 3 hours 45 hours Revision 45 hours Tutorials: Contact hours 8 x 1 hour 8 hours Preparation/revision 8 x 3 hours 24 hours Seminar: Preparation and delivery of presentation 30 hours Examination: Preparation 26 hours Examination 2 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	50% of homework problems successfully solved and seminar presentation: 25% Written examination (minimum pass mark: 50%): 75%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Electronic Devices and Circuit Technology**	**6 CP**
Module description	**Electronic Devices and Circuit Technology**	
Module code	**MP-15**	
Faculty/Subject/Department	Faculty 07/Physics/Department of Applied Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • learn the principles of operating and the properties of electronic components; • master the fundamentals of analogue and digital circuit technology; • be able to design basic circuits and connect these to complex circuit systems; • gain experience in building circuits and analysing them in practical situations by way of practical examples.	
Module content	• Simple passive and active devices, packaging • Diode and transistor characteristic curves • Analysis of linear networks • Analogue and digital circuit technology • Circuit design and layout • Practical experiments on analogue and digital circuit development and simulation	
Form(s) of instruction	Lecture (2 hours/week) Laboratory (40 hours)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 2 hours 30 hours Preparation/revision 1.5 hours per contact hour 45 hours Laboratory Contact hours 10 days at 4 hours/day 40 hours Preparation/revision 2 hours/laboratory day 20 hours Reports 4.5 hours/laboratory day 45 hours Total 180 hours	
Examination requirements	All laboratory reports accepted for submission, all tests passed.	
Form(s) of examination and contribution to final mark	Reports: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Introduction to Solid State Theory**	**6 CP**
Module description	**Introduction to Solid State Theory**	
Module code	**MP-16**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • master the mathematical fundamentals necessary for the theoretical description of solid states; • be able to autonomously solve quantum mechanics problems; • recognise the interrelationship of theoretical concepts and experimental problems.	
Module content	• Mathematical fundamentals of quantum mechanics • 2^{nd} quantisation • Hydrogen atom • Variation methods (Hartree equation) • Fermions and Bosons • Dirac equation • Scattering theory • Time dependent perturbation calculations	
Form(s) of instruction	Lecture (4 hours/week) Tutorials (1 hour/week) Computer tutorials (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture 15 x 4 hours 60 hours Revision 0.5 hours per contact hour 30 hours Tutorials 15 x 1 hour 15 hours Homework 15 x 2.5 hours 37.5 hours Computer tutorials 15 x 2 hours 30 hours Examination 1 x 3 hours 3 hours Preparation 4.5 hours Total 180 hours	
Examination requirements	50% of tutorial problems successfully solved.	
Form(s) of examination and contribution to final mark	Tutorial problems: 25% 1 written examination (3 hours) or 1 oral examination (30 minutes): 75%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	20/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Solid State Theory**	**6 CP**
Module description	**Solid State Theory**	
Module code	**MP-17**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • master the theories and models necessary for an understanding of solid states; • have knowledge of current research topics and related methodology; • be able to analyse experimental problems with appropriate theoretical methodology.	
Module content	• Crystal structures and symmetries • Reciprocal lattice • Phonons • Heat conduction • Electronic structure • Band structure methods (tight-binding, nearly free electrons, density functional theory) • Magnetisation • Electronic transport (ballistic, diffusive)	
Form(s) of instruction	Lecture (4 hours/week) Tutorials (1 hour/week) Computer tutorials (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture 15 x 4 hours 60 hours Revision 0.5 hours per contact hour 30 hours Tutorials 15 x 1 hour 15 hours Homework 15 x 2.5 hours 37.5 hours Computer tutorials 15 x 2 hours 30 hours Examination 1 x 3 hours 3 hours Preparation 4.5 hours Total 180 hours	
Examination requirements	50% of tutorial problems successfully solved.	
Form(s) of examination and contribution to final mark	Homework problems: 25% 1 written examination (3 hours) or 1 oral examination (30 minutes): 75%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	20/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Space Flight Systems**	**6 CP**
Module description	**Space Flight Systems**	
Module code	**MP-18**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiarised with the fundamentals of aerospace systems; • understand the fundamental principles of the design of different aerospace systems and their physical foundations; • be able to recognise and assess the distinctions between different aerospace systems.	
Module content	• Aerospace agencies and industry (DLR, ESA, NASA, industry) • Launcher systems (power requirements, components, project phases) • Chemical rockets (thermodynamic treatment, flow dynamics of the jet nozzle, rocket fuels, technology) • Low thrust engines (thermal thrusters, plasma thrusters, ion thrusters) • Energy supply (solar arrays, radio isotope batteries, reactors, batteries) • Thermal control • Data and communication systems (HF technology, satellite navigation) • Internal space station (manned space travel, components, supply chain, safety devices) • Project management (project structure, qualification)	
Form(s) of instruction	Lecture (4 hours/week) Tutorials (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 4 hours 60 hours Revision 15 x 3 hours 45 hours Tutorials: Contact hours 15 x 1 hour 15 hours Homework 15 x 2 hours 30 hours Examination : Preparation 28 hours Examination 2 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	1 written examination: 100%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	German, if required English	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Solid State and Molecular Electronics**	**6 CP**
Module description	**Solid State and Molecular Electronics**	
Module code	**MP-19**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • learn the physical fundamentals and functional principles of elementary semi-conductor devices; • recognise and be able to discuss differences in the characteristics of solid states compared to molecular materials; • be able to discuss the effect of small device dimensions in large-scale integrated circuits; • learn about new and modern components and their practical applications; • be able to relate fundamental component characteristics to underlying principles using selected examples.	
Module content	• Fundamentals of semi-conductor electronics: conduction mechanisms in metals and semi-conductors • p/n junctions, diode and transistor characteristic curves • Fundamentals and applications of magneto-electronic components • Micro-electronics: miniaturisation and integration • Molecular electronics; properties and functionality of nano-sized components	
Form(s) of instruction	Lecture (2 hours/week) Seminars (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 2 hours 30 hours Preparation/revision 1.5 hours per contact hour 45 hours Seminar: Contact hours 15 x 2 hours 30 hours Preparation/revision 2 hours per contact hour 60 hours Presentation including preparation 15 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Seminar presentation: 100%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Technical Informatics**	**6 CP**
Module description	**Technical Informatics**	
Module code	**MP-21**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, can be chosen as an extended module, as a non-physics module, or as a freely selected module.	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • gain knowledge of analogue and digital circuit technology, • be able to design logical circuitry; • gain fundamental knowledge of the structure of computers and micro-processors; • gain an overview of the most modern technologies and principles; • be able to apply their knowledge in the laboratory and in industry.	
Module content	Boolean algebra, circuit design, integrated circuits, semi-conductor memories, AD/DA converters, programmable logic, design of printed circuit boards, micro-controllers, micro-processors, interrupts, power supply, BUS systems, interfaces, optical and magnetic storage media, operating systems, virtual memory, driver models, networks, ISO layer models, wireless communication.	
Form(s) of instruction	Lecture (6 hours/week) Laboratory (4 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 12 x 2 hours 24 hours Preparation/revision 12 hours/12 hours 24 hours Laboratory in Digital Electronics 6 x 1 day at 4 hours each 24 hours Preparation/execution 4 hours/4 hours/experiment 48 hours Lab in Programmable Electronics (FPGA) 2 x 1 day á 6 hours 12 hours Lecture (FPGA) contact hours 3 hours Preparation/revision 1.5 hours/1.5 hours 3 hours Preparation/execution (FPGA) 4 hours/4 hours/experiment 16 hours Pre-colloquium (FPGA) 1 hour/experiment 2 hours Final examination 2 hours Preparation 22 hours Total 180 hours	
Examination requirements	All laboratory reports accepted for submission.	
Form(s) of examination and contribution to final mark	Laboratory reports: Digi-EPrak: 40% FPGA: 10% Final written examination: 50%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	20/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Module	**Introduction to Space Flight**	**6 CP**
Module description	**Introduction to Space Flight**	
Module code	**MP-22**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiarised with the fundamentals of space travel; • understand the fundamental principles of the design and structure of space missions and their physical fundamentals; • be able to recognise and assess the distinctions between different mission types.	
Module content	• Introduction (historical overview, mission structure and tasks) • Space environment (planetary system, earth atmosphere, particle radiation, radiation belts) • Orbital mechanics (Kepler orbits, coordinate systems, orbits in an earth-fixed reference system, orbit perturbations, determination of orbits, orbit tracking, analytical and numerical orbit models, orbit changes) • Rockets (Ziolkowsky equation, step principle) • Aerothermodynamics and re-entry • Satellite and probe missions (telecommunications, earth observation, interplanetary missions, reference missions)	
Form(s) of instruction	Lecture (4 hours/week) Tutorials (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 4 hours 60 hours Revision 15 x 3 hours 45 hours Tutorials: Contact hours 15 x 1 hour 15 hours Homework 15 x 2 hours 30 hours Examination: Preparation 28 hours Examination 2 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	1 written examination: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	German, if required English	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Applied Atomic Physics**	**6 CP**
Module description	**Applied Atomic Physics**	
Module code	**MP-23**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • have knowledge of the most important applications of atomic physics.	
Module content	• Fusion research, atomic-physics based diagnostic methods • Light sources in research and technology • Fundamentals of plasma physics • Applications in astrophysics • Element analysis, specimen characterisation • Atomic physics questions related to acceleration technology	
Form(s) of instruction	• Lecture (4 hours/week) • Tutorial (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 4 hours 60 hours Revision 15 x 3 hours 45 hours Tutorial: Contact hours 15 x 1 hour 15 hours Preparation/revision 30 hours Preparation for oral examination 29 hours Oral examination 1 hour Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Oral examination: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Plasma Physics and Ion Sources**	**6 CP**
Module description	**Plasma Physics and Ion Sources**	
Module code	**MP-24**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • understand the fundamentals of plasma physics and the interaction of ions and materials; • be able to autonomously solve current and future research and development problems; • have the ability to autonomously learn the required knowledge and skills.	
Module content	• Fundamentals of plasma physics; properties of plasmas and discharge modes • Technical and natural plasmas; in particular astrophysical plasmas • Theoretical and experimental fundamentals of plasma diagnostics • Plasma sources and ion beam sources • Aspects of plasma-assisted materials processing and material preparation • Applications of plasma physics in industry and research, in particular to the fields of ion sources and electric propulsion systems, including high voltage technology	
Form(s) of instruction	Lecture (2 hours/week) Tutorials and supplementary materials (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 2 hours 30 hours Revision 15 x 2 hours 30 hours Supplementary material and tutorials: Contact hours 15 x 2 hours 30 hours Homework 15 x 4 hours 60 hours Preparation of examination 28 hours Examination 2 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	1 written examination: 100%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Nano- and Microstructures in Sensor- and Actuator Systems**	**6 CP**
Module description	**Nano- and Microstructures in Sensor- and Actuator Systems**	
Module code	**MP-25**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiarised with sensors and actuators as applications of nano- and micro-structured materials; • understand the fundamental trends of miniaturisation and integration and electronic, mechanical, and chemical functional components; • recognise the mutual interdependence of structure, production process, and function of selected elements and be able to derive the connection between application-dependent requirements and fundamental material properties.	
Module content	• Nano-electronics • Bio-nano integration • Sensors with nano- and micro-structures • Actuators and system integration • Functional materials in nano- and micro-systems	
Form(s) of instruction	Lecture (2 hours/week) Tutorials (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 2 hours 30 hours Revision 15 x 2 hours 30 hours Supplementary material and tutorials: Contact hours 15 x 2 hours 30 hours Homework 15 x 6 hours 90 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	3 learning progress checks on topics covered in lecture: 100%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Introduction to Superconductivity**	**6 CP**
Module description	**Introduction to Superconductivity**	
Module code	**MP-26**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, BSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiar with the experimental and theoretical fundamentals of superconductivity; • know the major examples of how superconductivity has been applied.	
Module content	Experimental fundamentals of superconductivity; type 1 and type 2 superconductors, ceramic superconductors, high temperature superconductivity theory; London equations, Ginsburg-Landau theory, BCS theory, superconductivity in thin coatings, application examples; powerless electricity lines/electrical circuits, superconducting magnets, superconducting motors and generators, Josephson effect, SQUIDs, micro-calorimeter.	
Form(s) of instruction	Lecture (2 hours/week) Tutorials (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 30 x 2 hours 60 hours Preparation/revision 30 hours Tutorials: Contact hours 15 x 1 hour 15 hours Revision and homework 48 hours Preparation of examination 10 hours Examination 2 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	50% of maximum mark possible for homework: 25% Written examination (maximum pass mark: 50%): 75%	
Frequency, duration	Summer semester/winter semester; 2 semesters	
Intake capacity/Registration format	40/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Advanced Experimental Atomic Physics**	**6 CP**
Module description	**Advanced Experimental Atomic Physics**	
Module code	**MP-27**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • understand advanced concepts of the physics of structures and dynamics of atomic systems; • master the general fundamentals of the physics of atomic collision processes; • know the most important classes of atomic physics experiments and their theoretical background.	
Module content	• In-depth description of atomic states, from excitation to disintegration of singly and multiply excited states, influence of external fields on atomic states • In-depth description of atomic collision processes, symmetry principles, direct processes, resonance processes • Detailed treatment of modern acceleration-orientated experiments.	
Form(s) of instruction	Lecture (4 hours/week) Tutorials (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 4 hours 60 hours Revision 45 hours Tutorials: Contact hours 15 x 1 hour 15 hours Preparation/revision 30 hours Preparation for oral examination 29 hours Oral examination 1 hour Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Oral examination: 100%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Foundations of Research on Atomic Collision Processes**	**10 CP**
Module description	**Consolidation Module: Foundations of Research on Atomic Collision Processes**	
Module code	**MP-28 A**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be able to autonomously familiarise themselves with physical interrelationships by way of a module assignment related to current research and development; • be able to acquire the necessary physics knowledge to autonomously solve a module assignment (databases, literature reviews etc.); • be able to explain their work within a broader context and present results in a concise manner.	
Module content	Carrying out a project on a physics topic within the framework of research work currently being conducted in the department.	
Form(s) of instruction	Autonomous work under supervision (50 hours) Project work (120 hours)	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Execution of a study project (e.g. analysis of previous measurements of atomic cross-sections) 120 hours Research of literature on the topic 30 hours Literature review 80 hours Interpretation and scientific presentation of results in context of current scientific knowledge 50 hours Preparation of a presentation 18 hours Presentation and colloquium 2 hours Total 300 hours	
Examination requirements	Successful work on project, written report on the analyses and calculations with graphical depiction of results.	
Form(s) of examination and contribution to final mark	Written report on the analyses and calculations with graphical depiction of results: 50% Colloquium on study project: 50%	
Frequency, duration	Winter semester; Block courses.	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Modern Technologies of Conductive and Dielectric Materials**	**10 CP**
Module description	**Consolidation Module: Modern Technologies of Conductive and Dielectric Materials**	
Module code	**MP-28 B**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, Physics L3, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • master state-of-the-art methods for the preparation, measuring, characterisation, structural design, modelling and technical application of metallic, semi-conducting and insulating materials; • be able to integrate criteria for technical development into scientific questions; • be able to document experimental results in a clear and concise manner; • be able to conclusively present a field of research in context and discuss it in front of a group.	
Module content	• Thin film preparation, characterisation, development, and technical applications of functional structures • Modern methods of signal acquisition and processing, data analysis, and numerical modelling	
Form(s) of instruction	Lecture (2 hours/week) Seminar (1 hour/week) Laboratory (8 hours/week)	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 2 hours 30 hours Preparation/revision 2 hours per contact hour 60 hours Seminar: Contact hours 10 x 1 hour 10 hours Preparation/revision 2 hours per contact hour 20 hours Presentation including preparation 20 hours Laboratory: Contact hours 12 days at 5 hours/day 60 hours Preparation 40 hours Reports 5 hours/laboratory day 60 hours Total 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Seminar presentation: 20% Reports: 80%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	20/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Theoretical Hadron and Nuclear Physics**	**10 CP**
Module description	**Consolidation Module: Theoretical Hadron and Nuclear Physics**	
Module code	**MP-28 C**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall undertake a study project to: • by way of simple models master the structure of hadrons and their components (quarks and gluons) and calculate characteristic properties such as quark wave functions; • learn and securely master numerical methods for solving simple Dirac equations; • be able to calculate elementary scattering processes of hadrons using Born approximations.	
Module content	• Quark model of hadrons, multiplets, SU(3) colour interactions, antisymmetric wave functions for hadrons in position-spin-flavour colour space • Discrete algorithms for the solving of Dirac and Klein-Gordon equations • Scattering theory of complex collision partners, Dyson series and Born approximation, solving of scattering problems using Born approximations.	
Form(s) of instruction	Study project under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours 12 x 2 hours 24 hours Literature review 66 hours Analytical developments 70 hours Numerical developments 90 hours Drafting of a written abstract 50 hours Total 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Written abstract of the study project: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Transport Theory**		**10 CP**
Module description	**Consolidation Module: Transport Theory**		
Module code	**MP-28 D**		
Faculty/Subject/Department	Faculty 07/Physics		
Associated degree course(s)/Semester taken	MSc Physics		
Module coordinator	Cf. German Version		
Prerequisites			
Module guidance	Cf. German Version		
Learning outcomes	Students shall undertake a study project to: • understand the interrelationships between quantum mechanics in the phase space and semi-classical approximations and be able to quantitatively calculate these using simple models; • learn and securely master the method of Wigner transformations in 4 dimensions; • learn the numerical methods for solving simple transport equations; • numerically calculate and analyse the reactions of complex systems with simple interactions.		
Module content	• Operators in phase space, Green functions, spectral representations • Wigner transformations in 4 space-time dimensions, quantum mechanical and classical phase space densities • Molecular dynamics, Runge-Kutta integrations, Monte-Carlo methods, integration of high-dimensional systems.		
Form(s) of instruction	Study project under supervision		
Total workload in hours	300	Credit points: 10 ECTS credits	
Module composition/Workload in hours	Contact hours 12 x 2 hours Literature review Analytical developments Numerical developments Drafting of a written abstract Total	24 hours 66 hours 70 hours 90 hours 50 hours 300 hours	
Examination requirements			
Form(s) of examination and contribution to final mark	Written abstract of the study project: 100%		
Frequency, duration	Winter semester; 1 semester		
Intake capacity/Registration format	10/online		
Language of instruction	* See separate list for current semester (StudIP)		
Date/Literature	* See separate list for current semester (StudIP)		

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Detector Concepts of Subatomic Physics**	**10 CP**
Module description	**Consolidation Module: Detector Concepts of Subatomic Physics**	
Module code	**MP-28 E**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • learn the elementary interaction processes of particles and photons with matter; • develop a foundational knowledge of detector principles and fundamental measurement apparatus; • autonomously undertake literature reviews on the topic of detector concepts; • be able to solve experimental problems within a team; • be able to analyse and demonstrate measurement results.	
Module content	Interactions of charged and neutral particles in matter, absorption of low-energy and high-energy photons, Cherenkov and transition radiation, detector systems for position and momentum detection, energy measurements and calorimetry of electromagnetic and hadronic examples, particle identification, principles of gas, semi-conductor, and scintillation detectors, readout electronics and data collection systems, Monte-Carlo simulation of detector components.	
Form(s) of instruction	• Lecture (1 hour/week) • Seminar (1 hour/week) • Project (230 hours), in groups or autonomously Set-up of experimental equipment for use in a sub-atomic physical experiment, e.g. for the measurement of cosmic radiation or radioactive sources, undertaking of simulations for the optimisation of a detector concepts, calibration and qualification of detector components within the framework of current research, working on parts of current experiments, e.g. detector qualification with test beams, controlling of detector components or data collection for a detector system.	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 1 hour — 15 hours Preparation/revision — 20 hours Seminar: Contact hours 15 x 1 hour — 15 hours Preparation/revision — 20 hours Project: Contact hours — 110 hours Research and preparation — 60 hours Analysis and documentation — 59 hours Final colloquium — 1 hour Total — 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Written project report: 50% Final colloquium: 25% Seminar presentation: 25%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Introduction to Experimental Techniques in Atomic Physics**	**10 CP**
Module description	**Consolidation Module: Introduction to Experimental Techniques in Atomic Physics**	
Module code	**MP-28 F**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: 1) be able to autonomously solve a module assignment within the scope of current research and development; 2) learn the required technical knowledge and skills; 3) integrate themselves into a team of researchers and effectively work together with technical staff; 4) be able to present their own work and desired results in a clear and concise manner.	
Module content	Practical work in the field of vacuum technology, handling of ion and electron sources, beam transportation of charged particles, spectroscopy methods, high voltage technology and safety issues, measuring, controlling and regulating by using computers, analysis of experimental data and graphical representation of results using computer programmes, presentation techniques.	
Form(s) of instruction	Autonomous work under supervision (60 hours) Project work (180 hours)	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Project data collection and experimental control 60 hours Preparation for experiment 40 hours Undertaking of ion optical calculations with the help of computer programmes 60 hours Execution of a study project (e.g. measurement of atomic cross-section functions) 120 hours Preparation of presentation regarding work conducted 18 hours Presentation and colloquium 2 hours Total 300 hours	
Examination requirements	Successful work on projects undertaken, written elaboration of the undertaken work with graphical depiction of results.	
Form(s) of examination and contribution to final mark	Written elaboration of the undertaken work with graphical depiction of results: 50% Colloquium on study project: 50%	
Frequency, duration	Winter semester; Block courses	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Micro- and Nanostructured Semiconductors**	**10 CP**
Module description	**Consolidation Module: Micro- and Nanostructured Semiconductors**	
Module code	**MP-28 G**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • have an in-depth understanding of the characterisation methods of semi-conductor technology; • have the ability to produce new functional material systems and modify these for particular applications; • be able to develop new concepts for technical applications.	
Module content	• Top-down and bottom-up production methods for semi-conductor nano-structures • Optical characterisation methods such as Raman spectroscopy, photoluminescence spectroscopy, modulation spectroscopy • Magnetic resonance methods • Magnetotransport and thermoelectric measurements • Technical applications of micro- and nano-structured semi-conductors	
Form(s) of instruction	Lecture (2 hours/week) Project laboratory (150 hours) Block seminar for presentation of projects (30 hours)	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 2 hours 30 hours Revision 30 hours Laboratory: Contact hours 15 x 10 hours 150 hours Documentation/reports 50 hours Presentation on project including preparation 40 hours Total 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 50% Presentation: 50%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Bandstructure Calculations**	**10 CP**
Module description	**Consolidation Module: Bandstructure Calculations**	
Module code	**MP-28 H**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiarised with different methods for the calculation of band structures of solids; • understand the advantages and disadvantages of different methods; • be able to undertake calculations with at least one method.	
Module content	• All electron methods • Pseudopotential methods • Different basic approaches: plane waves, atomic orbitals, scattered waves • Muffin-tin approximation, atomic sphere approximation, full potential • Exchange-correlation potentials • Numerical methods	
Form(s) of instruction	Group study project under supervision Seminar (2 hours/week)	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours 15 x 2 hours Literature review Practical execution of calculations Preparation of presentation Total	30 hours 100 hours 120 hours 50 hours 300 hours
Examination requirements		
Form(s) of examination and contribution to final mark	Seminar presentation: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Theoretical Nuclear and Astrophysics**	**10 CP**
Module description	**Consolidation Module: Theoretical Nuclear and Astrophysics**	
Module code	**MP-28 I**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall undertake a study project to: • learn the structure of nuclear matter, neutron stars and the atomic nuclei composed of protons and neutrons, using simple models; • calculate the characteristic properties of single particle wave functions; • learn and master the numerical methods for solving simple Schrödinger and Dirac equations; • be able to calculate elementary scattering processes of hadrons on atomic nuclei.	
Module content	• One-Boson-Exchange Model for nuclear interactions in free space and in nuclear matter • Equation of state for nuclear matter and neutron star matter • Quasi-particle concepts of nuclear multi-particle theory • Calculation of nuclear reactions from the astrophysical to the relativistic energy range with quantum mechanical and semi-classical methods • Algorithms for the solving of Schrödinger, Dirac and Klein-Gordon equations, simple integral equations	
Form(s) of instruction	Study project under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours Literature review Analytical developments Numerical developments Drafting of a written abstract Total	24 hours 66 hours 70 hours 90 hours 50 hours 300 hours
Examination requirements		
Form(s) of examination and contribution to final mark	Written abstract of study project: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Current Problems of Theoretical Solid State Physics**	**10 CP**
Module description	**Consolidation Module: Current Problems of Theoretical Solid State Physics**	
Module code	**MP-28 J**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • master the models and theories required for the understanding of the physical properties of solids; • be able to work on a clearly defined topic within theoretical solid state physics and competently present the topic.	
Module content	• Electronic properties of semi-conductors • Spin-dependent transport phenomena • Magnetism • Quasi particles (phonons, magnons, excitons) • Current research topics in solid state theory • Diffusion in solid states • Disordered solid states • Percolation theory	
Form(s) of instruction	Group study project under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours Literature review and work on topic Drafting of a written abstract Total	30 hours 220 hours 50 hours 300 hours
Examination requirements		
Form(s) of examination and contribution to final mark	Written abstract of study project: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Experimental Hadron, Nuclear and Particle Physics**	**10 CP**
Module description	**Consolidation Module: Experimental Hadron, Nuclear and Particle Physics**	
Module code	**MP-28 K**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: 1) be able to acquaint themselves autonomously with the interrelated fields in physics through a module assignment within the scope of current research and development; 2) be able to autonomously acquire the necessary knowledge to solve a problem (databases, literature reviews etc.); 3) be able to present their own work in context and presented results achieved in a concise manner.	
Module content	Undertake a study project on a physics topic within the scope of research work currently being conducted in the department.	
Form(s) of instruction	Autonomous work under supervision (50 hours) Project work (120 hours)	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Execution of a study project (e.g. analysis of previous measurements of atomic function cross-sections) 120 hours Research of literature on the topic 30 hours Literature review 80 hours Interpretation and scientific presentation of results in context of current scientific knowledge 50 hours Preparation of a presentation 18 hours Presentation and colloquium 2 hours Total 300 hours	
Examination requirements	Successful work on project, written report on the analyses and calculations with graphical depiction of results.	
Form(s) of examination and contribution to final mark	Written report on analyses and calculations with graphical depiction of results: 50% Colloquium on study project: 50%	
Frequency, duration	Winter semester; Block courses	
Intake capacity/Registration format	12/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Plasma Theory**	**10 CP**
Module description	**Consolidation Module: Plasma Theory**	
Module code	**MP-28 L**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • have general knowledge of the physics of plasmas; • know the fundamental theoretical methods in plasma physics; • be able to differentiate specific plasma types; • be able to apply theoretical concepts and methods to plasma technologies and diagnostics.	
Module content	• Low temperature plasmas (gas discharge) • Complex plasmas • Strongly coupled plasmas • Relativistic plasmas • Transport theory	
Form(s) of instruction	Lecture (2 hours/week) Project work (150 hours) Block courses for presentation of projects (30 hours)	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Block lecture: Contact hours 5 x 6 hours 30 hours Revision 30 hours Project: Contact hours 15 x 10 hours 150 hours Documentation/reports 50 hours Presentation including preparation 40 hours Total 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 50% Presentation: 50%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Physics of Climate**		**10 CP**
Module description	**Consolidation Module: Physics of Climate**		
Module code	**MP-28 M**		
Faculty/Subject/Department	Faculty 07/Geography		
Associated degree course(s)/Semester taken	MSc Physics		
Module coordinator	Cf. German Version		
Prerequisites			
Module guidance	Cf. German Version		
Learning outcomes	Students shall be able to: • implement and interpret dynamic and stochastic climatological processes; • solve differential equation systems; • learn fundamental skills in the handling of numerical problems; • statistically analyse results; • work in a scientific manner.		
Module content	• Dynamic of the climate system and of single subsystems • Non-linear dynamics • Stochastic processes • Applied numerics • Applied statistics		
Form(s) of instruction	Study project under supervision		
Total workload in hours	300	Credit points: 10 ECTS credits	
Module composition/Workload in hours	Contact hours Literature review Numerical developments Analysis/interpretation Drafting of a written abstract Total	24 hours 66 hours 90 hours 70 hours 50 hours 300 hours	
Examination requirements			
Form(s) of examination and contribution to final mark	Written abstract of study project: 100%		
Frequency, duration	Winter semester; 1 semester		
Intake capacity/Registration format	2/online		
Language of instruction	* See separate list for current semester (StudIP)		
Date/Literature	* See separate list for current semester (StudIP)		

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Consolidation Module: Computer Simulations of Astrophysical Nucleosynthesis**	**10 CP**
Module description	**Consolidation Module: Computer Simulations of Astrophysical Nucleosynthesis**	
Module code	**MP-28 M**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	Lectures in Nuclear Astrophysics I and II, fundamental knowledge of the C++ or FORTRAN programming languages.	
Module guidance	Cf. German Version	
Learning outcomes	Students shall undertake a study project to: • gain an in-depth understanding of element formation beyond iron; • learn to independently undertake and analyse computer simulations of the gamma and rp processes.	
Module content	• Update of a reaction database with experimental data • Discussion and variation of the necessary input parameters (seed composition, density/temperature profile, process length, reaction rates) • Computer simulations • Analysis of results	
Form(s) of instruction	Study project under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours Introductory work on the topic Preparation of computer simulations Undertaking of simulations and analysis Drafting of a written abstract Total	24 hours 48 hours 132 hours 48 hours 48 hours 300 hours
Examination requirements		
Form(s) of examination and contribution to final mark	Written abstract of study project: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	2/online	
Language of instruction	German or English	
Literature	* See separate list for current semester (StudIP)	
Date	According to prior arrangement	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Multifunctional Thin Films**	**10 CP**
Module description	**Specialisation Module: Multifunctional Thin Films**	
Module code	**MP-29 A**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • know the most important epitaxial processes for the production of functional, semi-conducting thin films; • know the fundamentals of plasmas and plasma-assisted deposition processes; • know the physical-chemical methods of epitaxy; • understand the fundamental methods for the characterisation of thin films.	
Module content	• Fundamentals of the synthesis and characterisation of functional, semi-conducting thin films • Gas phase epitaxy, molecular beam epitaxy, and plasma-assisted deposition of films and multilayers • In situ and ex situ diagnostic methods • Applications of semi-conducting, functional thin films	
Form(s) of instruction	Laboratory (16 hours/week) Seminar (1 hour/week)	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Laboratory: Contact hours 15 x 4 half-days at 4 hours/day 240 hours Preparation/revision and reports 30 hours Seminar: Contact hours 15 x 1 hour 15 hours Seminar presentation including preparation 15 hours Total 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 80% Presentation: 20%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Applied Material Physics**	**10 CP**
Module description	**Specialisation Module: Applied Material Physics**	
Module code	**MP-29 B**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, Physics L3, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • master advanced laboratory work using good laboratory practices; • be familiar with modern methods for the preparation and characterisation of materials; • be able to determine physical-chemical characteristics of materials; • be able to discuss the relevance of material characteristics for technical applications; • recognise the interrelationship between practical work and fundamental theory; • document experiments in a clear and concise manner; • be able to present results from their experiments in context and in a conclusive manner and be able discuss these in front of a group.	
Module content	• Preparation of layers, micro- and nano-structuring • Surface analysis, measurement probes and their physical function principles • Influence of changing environmental conditions (composition, pressure, temperature) on material characteristics • Composition of functional structures, technical applications of oxidic, molecular, and hybrid materials	
Form(s) of instruction	Laboratory (16 hours/week) Seminar (1 hour/week)	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Laboratory: Contact hours 15 x 4 half-days at 4 hours/day 240 hours Preparation/revision and reports 30 hours Seminar: Contact hours 15 x 1 hour 15 hours Preparation of seminar presentation 15 hours Total 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 80% Seminar presentation: 20%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	6/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Current Problems and Technical Developments in Subatomic Physics**	**10 CP**
Module description	**Specialisation Module: Current Problems and Technical Developments in Subatomic Physics**	
Module code	**MP-29 C**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be familiarised with the experimental methods, simulation methods, and calculation techniques in nuclear, hadronic, and particle physics; • be able to explore the newest research results in this field using scientific literature.	
Module content	• Simulation and planning of experiments • Building and development of detector systems and methods of experimental nuclear, hadronic, and particle physics • Methods of real-time data collection	
Form(s) of instruction	Project work under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours 21 hours Literature review 79 hours Introduction to specialised measuring techniques 80 hours Undertaking of simulations 50 hours Drafting of a written abstract and presentation 70 hours Total 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Documentation of results: 50% Preparation of presentation: 50%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Physics of Dense and Hot Hadronic Matter**	**10 CP**
Module description	**Specialisation Module: Physics of Dense and Hot Hadronic Matter**	
Module code	**MP-29 D**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall undertake a specialised project to: • become familiar with the theoretical models of the properties of hadrons in dense and hot matter; • be able to construe effective hadronic Lagrange densities with specified conserved parameters; • be able to derive the movement equations of fields in 2 point approximations; • master chiral perturbation theory of the lowest order.	
Module content	• Relativistic Lagrange densities of interacting hadronic fields • Conserved currents and symmetry violation • Operators in second quantisation • Relativistic scattering theory • Chiral perturbation theory	
Form(s) of instruction	Project work under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours 7 x 3 hours Literature review Independent analysis Introduction to specialised numerical methods Examination preparation Examination Total	21 hours 79 hours 80 hours 120 hours 19 hours 1 hour 300 hours
Examination requirements		
Form(s) of examination and contribution to final mark	Oral examination: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Elementary Processes and the Structures of Atomic Systems**	**10 CP**
Module description	**Specialisation Module: Elementary Processes and the Structures of Atomic Systems**	
Module code	**MP-29 E**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall successfully familiarise themselves with the scientific-technical environment and the problem solving methods of experimental atomic physics; in this context the students will develop the skills to plan scientific work with the appropriate amount of time and effort; in particular a project plan for the master's dissertation will be developed.	
Module content	Questions related to the generation of electron and ion beams, in particular multiply-charged and highly-charged ions, detection of low-energy atomic particles, heavy ion atomic physics at ion storage rings and electron coolers, electron spectroscopy, atomic structure analysis, multi-electron processes, elementary reactions in plasmas, ultra-high vacuum technology, experimental methods for experiments with interacting beams of particles or photons.	
Form(s) of instruction	Project work under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours 100 hours Planning and preparation for measurements in atomic physics 60 hours Execution of test measurements/data analysis 120 hours Examination preparation 19 hours Final colloquium 1 hour Total 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Oral examination: 100%	
Frequency, duration	Winter semester, Block courses	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Particle Production in Elementary Reactions**	**10 CP**
Module description	**Specialisation Module: Particle Production in Elementary Reactions**	
Module code	**MP-29 F**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall undertake a specialised project to: • learn the experimental phenomenology of particle production reactions including data analysis; • design effective hadronic interactions with specified conserved quantities; • learn about reaction and scattering theory; • learn about and numerically master nuclear structure models in relation to their efficiency.	
Module content	• Scattering and reaction theory • Symmetry of interactions • Nuclear structure theory • Data analysis • Numerical methods of reaction and multi-particle physics	
Form(s) of instruction	• Study project under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours 7 x 3 hours: 21 hours Literature review: 79 hours Independent analysis: 80 hours Introduction to specialised numerical methods: 100 hours Examination preparation: 19 hours Oral examination: 1 hour Total: 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Oral examination: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Green's Functions in Solid State Theory**	**10 CP**
Module description	**Specialisation Module: Green's Functions in Solid State Theory**	
Module code	**MP-29 G**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • understand the relevance of Green's functions in solid state theory; • be able to apply methods of Green's functions in branches of solid state theory.	
Module content	• Solving the Schrödinger equation using Green's functions • Self-energy for the description of transport phenomena and inelastic effects • Green's function for the description of phonons • Non-equilibrium Green's function, Keldysh formalism	
Form(s) of instruction	Study project under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours 15 x 2 hours Literature review and work on topic Drafting of abstract Total	30 hours 220 hours 50 hours 300 hours
Examination requirements		
Form(s) of examination and contribution to final mark	Written abstract of study project: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Electric Space Flight Propulsion**	**10 CP**
Module description	**Specialisation Module: Electric Space Flight Propulsion**	
Module code	**MP-29 H**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • master important concepts for the production of aerospace propulsion systems; • know the fundamentals of plasma generation and diagnostics in aerospace propulsion systems and be able to practically apply these; • master the electronic control of electric thrusters; • be familiar with the sequence of the qualification of electric aerospace propulsion systems.	
Module content	• Fundamentals of plasma generation and diagnostics • Design, structure, and testing of electric aerospace propulsion systems • Integration of electric aerospace propulsion systems into aerospace systems	
Form(s) of instruction	Laboratory (60 hours) Seminar (15 hours)	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Laboratory tutorial: Contact hours 20 days at 3 hours/day 60 hours Revision 2 hours/laboratory day 40 hours Reports 3 hours/laboratory day 60 hours Literature review 40 hours Final report 55 hours Seminar: Contact hours 15 at 1 hour/day 15 hours Presentation 30 hours Total 300 hours	
Examination requirements	All laboratory reports accepted.	
Form(s) of examination and contribution to final mark	Seminar presentation: 50% Final report: 50%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	15/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Nuclear Density Functional Theory**	**10 CP**
Module description	**Specialisation Module: Nuclear Density Functional Theory**	
Module code	**MP-29 I**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall gain in-depth knowledge of: • the theory of nuclear matter, hyper nuclear matter, neutron star matter and atomic nuclei; • the principles and methods of nuclear quantum field theory and nuclear density functional theory; • the methods for solving field equations in mean field approximations and for dynamic correlations. • the reaction theory of leptons and hadrons in atomic nuclei	
Module content	• Nuclear density functional theory for atomic nuclei and in the SU(3)-flavour sector • Nuclear interactions in the meson exchange model and in the chiral effective field theory • Anti-protons and anti-baryons in nuclear matter • Calculation of nuclear two-point and four-point functions and the corresponding spectral functions • Leptonic and hadronic reactions in atomic nuclei and flavour generation in atomic nuclei • Algorithms for the solution of differential equation systems, integral-differential equations and integral equations	
Form(s) of instruction	Study project under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours 21 hours Literature review 79 hours Analytical development 80 hours Numerical development 120 hours Examination preparation 19 hours Examination 1 hour Total 300 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Oral examination: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Time Series Analysis**		**10 CP**
Module description	**Specialisation Module: Time Series Analysis**		
Module code	**MP-29 J**		
Faculty/Subject/Department	Faculty 07/Physics		
Associated degree course(s)/Semester taken	MSc Physics		
Module coordinator	Cf. German Version		
Prerequisites			
Module guidance	Cf. German Version		
Learning outcomes	Students shall: • understand the modern methods of time series analysis; • be able to apply these methods to the natural sciences and finance.		
Module content	• Random numbers and their generation • Long-term correlations • Multi-fractals • Extreme value statistics • Risk assessment		
Form(s) of instruction	Study project under supervision		
Total workload in hours	300	Credit points: 10 ECTS credits	
Module composition/Workload in hours	Contact hours Literature review and work on topic Drafting of abstract Total	30 hours 220 hours 50 hours 300 hours	
Examination requirements			
Form(s) of examination and contribution to final mark	Written abstract of study project: 100%		
Frequency, duration	Winter semester; 1 semester		
Intake capacity/Registration format	10/online		
Language of instruction	* See separate list for current semester (StudIP)		
Date/Literature	* See separate list for current semester (StudIP)		

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Specialisation Module: Properties of Elementary Particles and their Bound States**	**10 CP**
Module description	**Specialisation Module: Properties of Elementary Particles and their Bound States**	
Module code	**MP-29 K**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall undertake a specialised project to: • understand concepts for the quantum field theoretical description of elementary particles; • become familiar with theoretical mechanisms for mass generation in fermions; • master theoretical mechanisms for the formation of bound states.	
Module content	• Relativistic Lagrange densities of interacting elementary particles; • Conserved flows and symmetry violations • Functional equations such as Dyson-Schwinger equations, Bethe-Salpeter equations, or the functional renormalisation group.	
Form(s) of instruction	Project work under supervision	
Total workload in hours	300	Credit points: 10 ECTS credits
Module composition/Workload in hours	Contact hours 7 x 3 hours Literature review Independent analysis Introduction to specialised numerical methods Examination preparation Oral examination Total	21 hours 79 hours 80 hours 100 hours 19 hours 1 hour 300 hours
Examination requirements		
Form(s) of examination and contribution to final mark	Oral examination: 100%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Measurement Electronics and Data Acquisition**	**6 CP**
Module description	**Measurement Electronics and Data Acquisition**	
Module code	**MP-30 A**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • learn how analogue and digital measurement amplifiers are constructed and function; • gain experience in constructing technological measurement and control circuits; • apply skills learned to practical examples in the fields of measurement data collection and processing; • process and present results in a clear and concise manner.	
Module content	• Modern components of analogue and digital measurement technology • Operation amplifiers, lock-in amplifiers • Analogue and digital signal sources and filters • PID controllers • Arithmetic circuits • AD/DA converters	
Form(s) of instruction	Lecture (2 hours/week) Laboratory (half-day, 10 course days)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 2 hours 30 hours Preparation/revision 1 hour per contact hour 30 hours Laboratory: Contact hours 10 days at 5 hours/day 50 hours Preparation/revision 2 hours/laboratory day 20 hours Reports 5 hours/laboratory day 50 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 100%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	15/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Microcontroller Technology**	**6 CP**
Module description	**Microcontroller Technology**	
Module code	**MP-30 B**	
Faculty/Subject/Department	Faculty 07/Physics/Department of Applied Physics	
Associated degree course(s)/Semester taken	MSc Physics, can be chosen as a non-physics module or as an elective module	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • learn about the functional principle and the individual components of micro-controllers with the aid of a development system; • master programme design in the context of structured and modular programming; • be able to practically apply micro-controller technology to examples from the field of measurement technology; • be able to structure the programme documentation in a clear and concise manner.	
Module content	• Hardware-orientated programme development • Counter and timer devices • Data communication and interfaces • AD/DA-converters • Interrupt systems • Memory structures • Micro-controller architectures	
Form(s) of instruction	Lecture (2 hours/week) Laboratory (10 course days, each 5 hours)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 2 hours 30 hours Preparation/revision 1 hour per contact hour 30 hours Laboratory: Contact hours 10 days at 5 hours/day 50 hours Preparation/revision 2 hours/laboratory day 20 hours Reports 5 hours/laboratory day 50 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 100%	
Frequency, duration	Winter semester/summer semester; 1 semester	
Intake capacity/Registration format	12/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Optional Module: Programmable Electronics**	**6 CP**
Module description	**Optional Module: Programmable Electronics**	
Module code	**MP-30 C**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • gain knowledge of digital electronics; • learn to use hardware description language (e.g. VHDL); • be able to design and programme digital circuits; • recognise and be able to solve electronic timing problems; • gain fundamental knowledge of the set-up of computers and micro-processors; • gain an overview of the latest technology and principles of electronics; • be able to apply their knowledge in the laboratory and in industry.	
Module content	Digital electronics, Boolean algebra, circuit design, integrated circuits, semi-conductor memories, VHDL.	
Form(s) of instruction	Lecture (2 hours/week) Laboratory (48 hours) in small groups: VHDL hardeware description language, application of logic analysers, design, simulation, and testing of electronic circuits, development and programming of complex logic circuits.	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture: Contact hours 15 x 2 hours 30 hours Preparation/revision 30 hours Laboratory: Contact hours 12 x 1 day at 4 hours/day 48 hours Colloquium 12 x 0.5 hours 6 hours Preparation/reporting 2 hours/2 hours/experiment 8 hours Final colloquium: preparation 17 hours Final colloquium 1 hour Total 180 hours	
Examination requirements	All laboratory reports accepted.	
Form(s) of examination and contribution to final mark	Laboratory reports: 50% Colloquia: 25% Final colloquium: 25%	
Frequency, duration	Winter semester; 2 semesters	
Intake capacity/Registration format	12/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Learning by Teaching (MSc degree course)**	**6 CP**
Module description	**Learning by Teaching (MSc degree course)**	
Module code	**MP-30 D**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall undertake a teaching project: • supervising younger students from the bachelor's degree course in Physics in tutorials and laboratories under the guidance of and in consultation with the responsible university instructors; • learning how to explain physics concepts; • applying teaching methods in the classroom; • learning simple methods of evaluation; • critically evaluating the applied methods.	
Module content	• Under the guidance of a university instructor guide students from the BSc Physics degree course in tutorials or laboratories • Teach physics fundamentals (at the same time reviewing and strengthening their own knowledge) • Teaching methods, • Monitoring of student progress • Evaluation through questionnaires and their analysis • Critical review of applied methods	
Form(s) of instruction	Teaching project	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Example: Tutorials for basic courses in theoretical physics Contact hours with university instructor 30 hours Contact hours with students 30 hours Preparation of tutorials (laboratories) 30 hours Correction of homework (reports) 60 hours Drafting a questionnaire 10 hours Evaluation and written report 20 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Written report with consideration of student evaluation: 100%	
Frequency, duration	Winter semester/summer semester; 1 semester	
Intake capacity/Registration format	20/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Nuclear Astrophysics and Physics of Exotic Nuclei**	**6 CP**
Module description	**Nuclear Astrophysics and Physics of Exotic Nuclei**	
Module code	**MP-30 E**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall learn and understand: • The temporal and spatial structure of the universe • Phases of star formation and development • Stellar burning phases and energy generation • Places and processes for the formation of chemical elements • Formation of exotic nuclides in the laboratory • Modern experimental methods with acceleration equipment • Phenomena, structure, and properties of exotic nuclei. Students are familiar with results and current research problems in cosmology and nuclear astrophysics and in the field of physics of atomic nuclei beyond the valley of stability.	
Module content	Big bang theory, spatial structures in the universe, star formation and development, s, r, rp processes, astrophysical network calculations, fragmentation, fission, nuclear fusion, electromagnetic separators, detector devices for heavy ions, nuclear models, charge and matter distribution in atomic nuclei, equation of state of nuclear matter, nuclear reactions, mass spectrometry, gamma-spectroscopy, super-heavy elements, applications in medicine and environment safety.	
Form(s) of instruction	Winter semester: • Lecture: Nuclear Astrophysics (2 hours/week) • Lecture tutorials (1 hour/week) Summer semester: • Lecture: Physics of Exotic Nuclei (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Winter semester: Lecture (contact hours) 15 x 2 hours — 30 hours Revision 15 x 2 hours — 30 hours Homework 15 x 3 hours — 45 hours Tutorials (contact hours) 15 x 1 hour — 15 hours Summer semester: Lecture (contact hours) 15 x 2 hours — 30 hours Revision 15 x 2 hours — 15 hours Examination preparation 13 x 1 hour — 13 hours Examination 1 x 2 hours — 2 hours Total — 180 hours	
Prerequisites for examination	At least 50% of maximum possible mark on homework.	
Form(s) of examination and contribution to final mark	Written examination: 100%	
Frequency, duration	Winter semester; 2 semesters	
Intake capacity/Registration format	30/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Laboratory Exercises in Semiconductor Physics I**	**6 CP**
Module description	**Laboratory Exercises in Semiconductor Physics I**	
Module code	**MP-30 F**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • learn advanced laboratory work using good laboratory practices • be able to document experiments in a clear and concise manner; • be able to clearly present scientific results in context and discuss in front of a group; • learn methods for the preparation and characterisation of semi-conductor structures and apply these to a concrete problem.	
Module content	• Manufacture of semi-conductor structures with MBE, CVD, or sputtering • Structural characterisation of semi-conductor structures • Electronic characterisation of semi-conductor structures • Phononic characterisation of semi-conductor structures	
Form(s) of instruction	Laboratory (8 hours/week) Seminar (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Laboratory: Contact hours half-days at 4 hours each x 15 weeks 120 hours Preparation/revision, writing of reports 30 hours Seminar: Contact hours 15 x 1 hour 15 hours Seminar presentation including preparation 15 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 80% Seminar presentation: 20%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Laboratory Exercises in Semiconductor Physics II**	**6 CP**
Module description	**Laboratory Exercises in Semiconductor Physics II**	
Module code	**MP-30 G**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics, MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • learn advanced laboratory using good laboratory practices • be able to document experiments in a clear and concise manner; • be able to clearly present scientific results in context and discuss in front of a group; • learn methods for the measurement of dynamic processes of semi-conductor structures and semi-conductor component structures and apply these to a concrete problem.	
Module content	• Transport processes in semi-conductor structures and devices • Emission properties of semi-conductor structures • Sensor properties of semi-conductor structures	
Form(s) of instruction	Laboratory (8 hours/week) Seminar (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Laboratory: Contact hours 2 half-days at 4 hours x 15 weeks 120 hours Preparation/revision, writing of reports 30 hours Seminar: Contact hours 15 x 1 hour 15 hours Seminar presentation including preparation 15 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 80% Seminar presentation: 20%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Laboratory Exercises in Subatomic Physics I**	**6 CP**
Module description	**Laboratory Exercises in Subatomic Physics I**	
Module code	**MP-30 H**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be able to document experiments in a clear and concise manner; • be able to clearly present scientific results in context and discuss in front of a group; • learn advanced methods for the analysis of particle properties.	
Module content	• Momentum, energy, mass and time-of-flight measurements • Monte-Carlo simulations and object-orientated analysis tools • Practical application of relativistic kinematics • Modern methods in the field of data collection and electronics	
Form(s) of instruction	Laboratory (8 hours/week) Seminar (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Laboratory: Contact hours 2 half-days at 4 hours x 15 weeks 120 hours Preparation/revision, writing of reports 30 hours Seminar: Contact hours 15 x 1 hour 15 hours Seminar presentation including preparation 15 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 80% Seminar presentation: 20%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Laboratory Exercises in Subatomic Physics II**		**6 CP**
Module description	**Laboratory Exercises in Subatomic Physics II**		
Module code	**MP-30 I**		
Faculty/Subject/Department	Faculty 07/Physics		
Associated degree course(s)/Semester taken	MSc Physics		
Module coordinator	Cf. German Version		
Prerequisites			
Module guidance	Cf. German Version		
Learning outcomes	Students shall: • be able to document experiments in a clear and concise manner; • be able to clearly present scientific results in context and discuss in front of a group; • learn advanced measuring techniques for sub-atomic physics and be able to apply these; • become familiar with modern analysis and simulation methods.		
Module content	• Measuring techniques for the determination of kinematic parameters of nuclei, baryons, mesons, leptons, and photons • Capturing and analysing data in multi-parameter experiments • Analysis and preparation of results with modern object oriented software packages		
Form(s) of instruction	Laboratory (8 hours/week) Seminar (1 hour/week)		
Total workload in hours	180	Credit points: 6 ECTS credits	
Module composition/Workload in hours	Laboratory: Contact hours 2 half-days at 4 hours x 15 weeks 120 hours Preparation/revision, writing of reports 30 hours Seminar: Contact hours 15 x 1 hour 15 hours Seminar presentation including preparation 15 hours Total 180 hours		
Examination requirements			
Form(s) of examination and contribution to final mark	Reports: 80% Seminar presentation: 20%		
Frequency, duration	Summer semester; 1 semester		
Intake capacity/Registration format	10/online		
Language of instruction	* See separate list for current semester (StudIP)		
Date/Literature	* See separate list for current semester (StudIP)		

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Laboratory Exercises in Solid State and Molecular Electronics**	**6 CP**
Module description	**Laboratory Exercises in Solid State and Molecular Electronics**	
Module code	**MP-30 J**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics; MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • master advanced laboratory work under supervision using good laboratory practices; • be able to discuss the relevance of film characteristics for electronic properties; • be able to document experiments in a clear and concise manner; • be able to clearly present scientific results in context and discuss in front of a group.	
Module content	• Sample preparation and characterisation • Thin film devices	
Form(s) of instruction	Laboratory (8 hours/week) Seminar (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Laboratory: Contact hours 2 half-days at 4 hours x 15 weeks 120 hours Preparation/revision 2 hours/week 30 hours Seminar: Contact hours 15 x 1 hour 15 hours Seminar presentation including preparation 15 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Final report: 40% Final colloquium: 40% Seminar presentation: 20%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	5/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Laboratory Exercises in Preparation and Characterisation of Thin Films**	**6 CP**
Module description	**Laboratory Exercises in Preparation and Characterisation of Thin Films**	
Module code	**MP-30 K**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics; MSc Advanced Materials	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • master advanced laboratory work under supervision using good laboratory practices; • know modern preparation and characterisation methods for coatings; • be able to discuss film characteristics in the context of technical applications; • be able to discuss the relevance of film characteristics for electronic properties; • be able to document experiments in a clear and concise manner; • be able to clearly present scientific results in context and discuss in front of a group.	
Module content	• Film preparation from a liquid of gaseous phase • Characterisation of precursors, films, and surfaces	
Form(s) of instruction	Laboratory (8 hours/week) Seminar (1 hour/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Laboratory: Contact hours 2 half-days at 4 hours x 15 weeks 120 hours Preparation/revision 2 hours/week 30 hours Seminar: Contact hours 15 x 1 hour 15 hours Seminar presentation including preparation 15 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Final report: 40% Final colloquium: 40% Seminar presentation: 20%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	5/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Laboratory Exercises in Atomic Physics I**	**6 CP**
Module description	**Laboratory Exercises in Atomic Physics I**	
Module code	**MP-30 L**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be able to document experiments in a clear and concise manner; • be able to clearly present scientific results in context and discuss in front of a group; • learn advanced methods for the analysis of atomic collision processes and atomic structures.	
Module content	• Calculation of atomic energy levels • Ion and electron optics • Generation of beams of charged particles • Detectors for photons and atomic particles • Experimental control and data collection • Interactions of radiation with matter • Analysis of complex experimental data	
Form(s) of instruction	Laboratory Seminar	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Laboratory: Contact hours 2 half-days at 5 hours x 15 weeks 120 hours Preparation/revision, writing of reports 30 hours Seminar: Contact hours 10 hours Seminar presentation including preparation 20 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 80% Seminar presentation: 20%	
Frequency, duration	Winter semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Laboratory Exercises in Atomic Physics II**	**6 CP**
Module description	**Laboratory Exercises in Atomic Physics II**	
Module code	**MP-30 M**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	Students shall: • be able to document experiments in a clear and concise manner; • be able to clearly present scientific results in context and discuss in front of a group; • learn advanced methods for the analysis of atomic collision processes and atomic structures.	
Module content	• Calculation of atomic energy levels • Ion and electron optics • Generation of beams with charged particles • Detectors for photons and atomic particles • Experimental control and data collection • Interactions of radiation with matter • Analysis of complex experimental data	
Form(s) of instruction	Laboratory Seminar	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Laboratory: Contact hours 2 half-days at 5 hours x 15 weeks 120 hours Preparation/revision, writing of reports 30 hours Seminar: Contact hours 10 hours Seminar presentation including preparation 20 hours Total 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Reports: 80% Seminar presentation: 20%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	10/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Advanced Nuclear Astrophysics - Stellar Nucleosynthesis**	**6 CP**
Module description	**Advanced Nuclear Astrophysics - Stellar Nucleosynthesis**	
Module code	**MP-30 N**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	In-depth understanding of: • hydrodynamic and explosive burning phases in stars: • locations and processes of nucleosynthesis • theoretical description of element formation with models • possibilities for the measurement of extraterrestrial samples Knowledge of current experimental and practical problems in stellar nucleosynthesis.	
Module content	Detailed description: of star formation and development, of hydrostatic and explosive burning phases, of nucleosynthesis of heavy elements (s-, r-, p-processes), of supernova explosions and their repercussions, of astrophysical network calculations, of the measurement of extraterrestrial samples.	
Form(s) of instruction	Lecture (2 hours/week) Seminar (2 hours/week)	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Lecture (contact hours) 15 x 2 hours — 30 hours Revision 15 x 2 hours — 30 hours Seminar preparation 2 x 2 hours — 4 hours Reading of literature on seminar topic — 28 hours Seminar report — 40 hours Seminar: 15 x 2 hours — 30 hours Examination preparation 1 x 16 hours — 16 hours Examination — 2 hours Total — 180 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Seminar presentation: 100% Written examination (minimum pass mark: 50%)	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	15/online	
Language of instruction	German or English	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Nuclear Reactions - Introduction, Current Research and Applications**	**6 CP**
Module description	**Nuclear Reactions - Introduction, Current Research and Applications**	
Module code	**MP-30 O**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites		
Module guidance	Cf. German Version	
Learning outcomes	• Gain an overview of current research in nuclear physics; • Learn experimental techniques; • Master the mathematical fundamentals/formal descriptions of reaction chains; • Ability to work autonomously using articles from scientific literature; • Ability to prepare and present a scientific presentation.	
Module content	• Nuclear models and nuclear energy • Elastic and (deep) inelastic scattering • Nucleon transfer reactions • Fusion and fission • Projectile/target fragmentation • Current research (heavy elements, high-precision mass measurement, exotic nuclei) • Project with radioactive beams	
Form(s) of instruction	Winter semester: • Lecture (2 hours/week) • Seminar (2 hours/week) Summer semester: • Lecture (2 hours/week) • Examination	
Total workload in hours	180	Credit points: 6 ECTS credits
Module composition/Workload in hours	Winter semester: Lecture (contact hours) 14 x 2 h — 28 hours Revision 14 x 2 h — 28 hours Seminar preparation 3 x 2 h — 6 hours Research of literature on the topic — 15 hours Seminar elaboration — 15 hours Seminar 5 x 2 h — 10 hours Summer semester: Lecture (contact hours) 12 x 2 h — 24 hours Revision 12 x 2 h — 24 hours Preparation for examination — 28 hours Written examination — 2 hours	
Examination requirements		
Form(s) of examination and contribution to final mark	Seminar presentation: 100% Written examination (minimum pass mark: 50%)	
Frequency, duration	Winter semester; 2 semesters	
Intake capacity/Registration format	Approx. 15/online	
Language of instruction	German, English if required	
Date/Literature	* See separate list for current semester (StudIP)	

Please note that only the German version of the modules is official and legally binding. The English version is for informative purposes only.

Module	**Master's Dissertation**	**30 CP**
Module description	**Master's Dissertation**	
Module code	**MP-31**	
Faculty/Subject/Department	Faculty 07/Physics	
Associated degree course(s)/Semester taken	MSc Physics	
Module coordinator	Cf. German Version	
Prerequisites	Final mark of 1st and 2nd semesters	
Module guidance	Cf. German Version	
Learning outcomes	• Students shall be able to carry out an independent scientific project of limited time and scope, document their results, and defend them in a discussion.	
Module content	• Conduct a research/scientific project • Analyse and prepare results • Draft a scientific report for the master's dissertation on the experiment and the results obtained	
Form(s) of instruction	All-day instruction on academic work within a scientific team	
Total workload in hours	900	Credit points: 30 ECTS credits
Module composition/Workload in hours	22 weeks, full-time Total	900 hours 900 hours
Examination requirements		
Form(s) of examination and contribution to final mark	Master's dissertation: 100%	
Frequency, duration	Summer semester; 1 semester	
Intake capacity/Registration format	60/online	
Language of instruction	* See separate list for current semester (StudIP)	
Date/Literature	* See separate list for current semester (StudIP)	