Examination regulations for the Master's programme in Physics of the Faculty of Mathematics and Natural Sciences of the University of Kassel, April 24, 2019

Content

Annex

§ 1 Scope of application

The subject examination regulations for the consecutive, English-language Master's programme in Physics of the Faculty of Mathematics and Natural Sciences at the University of Kassel supplement the General Regulations for subject examination regulations with the degrees Bachelor and Master (AB Bachelor/Master) at the University of Kassel in the currently valid version.

§ 2 Academic degrees, profile type

(1) Upon passing the Master's examination, the Faculty of Mathematics and Natural Sciences awards the academic degree Master of Science.

(2) The profile of the Master's programme in Physics is designed as a more research-oriented programme predominantly in English.

§ 3 Standard period of study, scope of studies

(1) The standard period of study for the Master's program, including the Master's thesis and colloquium, is four semesters.

(2) A total of 120 credits will be awarded for the successfully completed Master's course. Of these, 30 credits are allocated to the Master's degree module.

§ 4 Start of studies

The Master's programme can be taken up in the winter and summer semester.

§ 5 Audit Committee

(1) Decisions on examination matters in the Master's program in Physics are made by the Master Physics Examination Board.

(2) The members of the Audit Committee are
a) three professors from the Institute of Physics at the University of Kassel
(b) a research assistant from the Institute of Physics at the University of Kassel,
c) a student from the Master's programme in Physics or the former Master's programme in Physik at the University of Kassel.

§ 6 Special admission requirements

(1) Admission to the Master's programme is only open to those who
a) has passed the Bachelor examination in physics or
(b) holds a degree of at least an equivalent level in the same or related subject from another university or a university of applied sciences with a standard period of study of at least six semesters; or
c) has completed at least an equivalent foreign degree in the same or related subject area with a standard period of study of at least six semesters

(2) The professional profile of the degree in accordance with paragraph 1(b) and (c) has to meet the following requirements.

- The applicant has a solid basic knowledge of experimental physics and theoretical physics in the fields of mechanics, electrodynamics and optics, thermodynamics and statistics, atomic and molecular physics, condensed matter physics, nuclear and elementary particle physics, quantum mechanics and mathematics.
- The applicant has applied and in some cases deepened his or her knowledge in an exemplary manner to physical tasks, thus acquiring basic problem-solving skills.
- The applicant has understood fundamental principles of physics as well as their mathematical formulation and has acquired methods suitable for modelling and simulating relevant physical processes.
- The applicant is able to independently classify physical and sometimes comprehensive problems that require a goal-oriented and logically based approach on the basis of scientific knowledge and is able to analyse or solve problems using scientific and mathematical methods.
- The applicant is able to apply his/her knowledge in different fields and to act responsibly in his/her professional activity. They can also identify new developments in their field of expertise and integrate their methodology into their work - if necessary after appropriate qualification.
- The applicant is familiar with the usual communication procedures in the scientific world and is familiar with the English language.
- The applicant is qualified to solve suitable scientific problems and to present his/her results in oral and written form.
- The applicant knows the rules of good scientific practice.

If the applicant does not meet the requirements for admission to the Master's programme, the examination board can grant admission under the condition that the lack of knowledge up to the time of the Master's thesis is proven by successful completion of certain modules of up to 30 credits.

(3) For admission, proof of language skills in English at level B2 of the Common European Framework of Reference for Languages must be provided. The provisions of the Framework of Reference for Language Proficiency according to the regulations of the Common European Framework of Reference for Languages in Bachelor's and Master's Programs at the University of Kassel, as amended, shall apply to the proof.

(4) In order to determine whether the requirements in accordance with paragraphs 1 and 2 are met, the examination board shall appoint two professors from among the members of the examination board. The determination is made on the basis of the written application documents.

§ 7 Module examinations, repetitions

(1) The module examinations during the course of study are offered in a temporal and factual context with a module.

(2) The following are eligible as examination papers

- written examination (30 to 180 minutes),
- oral examination (15 to 60 minutes),
- Seminar lecture
- internship report
- and, if applicable, other examination achievements described in the study and examination plan.

The type of examination of a module or submodule is determined by the lecturer at the beginning of the course to which the module examination refers, within the framework of the specifications of the study and examination plan.

(3) The module examinations during the course of study may also consist of several submodule examinations. The module examination shall be deemed passed if all submodule examinations have been graded at least "sufficient" (4.0).

(4) Failed module examinations can be repeated twice. A repetition of passed module examinations is not permitted. If a module examination consists of several submodule examinations, the submodule examinations graded "failed" (5,0) may be repeated twice. A repetition of passed submodule examinations is not permitted.

(5) A passed elective compulsory module may be changed for the purpose of improving grades. In addition to the compulsory and elective modules provided for in the examination regulations, additional modules may be taken and shown in the transcript of records (additional modules). The binding assignment as an additional module takes place at the latest upon registration for the Master's thesis.

(6) In agreement with the examiners, module examination services can be rendered either in English or German.

§ 8 Examination parts of the Master's degree

(1) The Master's examination consists of the following module examinations including the Master's degree module as per § 10 with the corresponding credits.

Compulsory modules (49 credits)		
PMP 1	Advanced Lab (Master)	9 c
PMP 2	Experimental Physics Seminar	5 c
PMP 3	Theoretical Physics Seminar	5 c
PMP 4	Specialization in scientific area	15 c
PMP 5	Methodological Expertise and Project Planning	15 c
Elective modules in theoretical physics (at least 8 credits)		
PMWT 1	Theoretical Solid State Physics	8 c
PMWT 2	Quantum Mechanics II	8 c
PMWT 3	Computational Physics	5 c
PMWT 4	Reviews of Modern Theoretical Physics	5 c
PMWT 5	Advanced Methods in Theoretical Physics	5 c
Elective modules in experimental physics (minimum 12 credits)		
PMWE 1	Applied Semiconductor Physics	6 c
PMWE 2	Semiconductor Laser	6 c
PMWE 3	Ultrashort Laserpulses and their Applications	8 c
PMWE 4	Surface Science	4 c
PMWE 5	Molecular Physics and Spectroscopy I	6 c
PMWE 6	Nano Scale Quantum Optics	6 c
PMWE 7	Seminar Astrophysics and Cosmology	5 c
PMWE 8	General Theory of Relativity and Cosmology	5 c
PMWE 9	Molecular Physics and Spectroscopy II	6 c
PMWE 10	Physics with Synchrotron Radiation	3 c
PMWE 11	Thin Film Physics	3 c
PMWE 12	Advanced Nano Scale Quantum Optics	6 c
Non-physical elective modules (minimum 9 and maximum 12 credits)		
PMWS 1	Additive Key Competencies	3 up to 12 c
PMWS 2	Non-physical Elective Modules	5 to 12 c
PMWS 3	Occupational Internship	8 to 12 c

Master degree module (30 credits)		
PMP 6	Master's Degree Module	30 c
Total		120 c

(2) The board of examiners may allow further elective modules and assign them to the appropriate areas.

(3) At least 8 credits must be acquired and earned from the elective modules in theoretical physics.

(4) At least 12 credits must be acquired and earned in the field of elective modules in experimental physics.

(5) At least 9 credits must be acquired and contributed from the field of non-physical elective modules. A maximum of 12 credits from this area may be earned.

§ 9 Key competences

In the Master's programme in Physics a total of at least 6 credits must be acquired in the area of key competencies, of which at least 3 credits must be additive and at least 3 credits must be integrated. Additive key competencies can be chosen from the correspondingly designated offer of the University of Kassel. The examination board decides on the crediting of additional additive key competencies upon application by the student. The framework requirements for key competencies in Bachelor and Master courses of study at the University of Kassel apply in the respective valid version.

§ 10 Master degree module

(1) Master's thesis and Master's colloquium form the Master's degree module. For this module 30 credits are awarded. Thereof 25 credits are assigned to the master thesis and 5 credits to the master colloquium.

(2) The topic of the Master's thesis will be issued after the 2nd semester at the earliest. It can only be issued if the successful completion of the following compulsory modules can be proven:

PMP 1	Advanced Lab (Master)
PMP 2	Experimental Physics Seminar
PMP 3	Theoretical Physics Seminar
PMP 4	Specialization in scientific area
PMP 5	Methodological expertise and Project Planning

and at least 30 credits have been acquired in the elective section. The issue of the topic and the appointment of the reviewer who is to supervise the thesis is made by the examination board. The student has a right of proposal.

(3) The Master's thesis has to be completed within six months and begins on the day the topic is announced. The topic of the Master's thesis may only be returned once and only within eight weeks. It must be chosen in a way that it can be solved within the period provided.

(4) If the first deadline cannot be met for reasons beyond the candidate's control, the board of examiners will extend the deadline by the period of time during which the candidate is unable to attend, but by no more than 13 weeks.

(5) The Master's thesis must be written in English.

(6) The Master's thesis must be submitted in due time in the form of three bound copies as well as on a
data carriers to the examination board.

(7) The Master's thesis is to be presented within the framework of a Master's colloquium. In addition to the candidate, the colloquium shall be attended by the participants of the seminar at which the colloquium is held. Students of the Master's programme in Physics are entitled to attend the colloquium as listeners. The Master's colloquium should take place no later than two months after submission of the thesis. The duration for the entire colloquium is 60 minutes. Participation in the Master's Colloquium requires that at least the grade "sufficient" (4,0) has been achieved in the Master's thesis.

(8) In order to pass the final module, the Master thesis and Master colloquium must have been graded at least "sufficient" (4,0). 20% of the grade of the colloquium is included in the final module grade. A Master colloquium not graded at least with "sufficient" (4,0) can be repeated twice.

§ 11 Formation and weighting of the grade

(1) A module has been passed and can be counted as part of the Master's degree if the module has been graded at least "sufficient" (4,0).

(2) If a module grade consists of several module subtests, the subtests shall be considered equally as long as the module description does not provide for a specific weighting.

(3) The overall grade is calculated from the grades of the module examinations and the grade of the master module. The grades of the individual modules are each weighted by the number of credits.

§ 12 Transitional provisions, entry into force

(1) These examination regulations shall enter into force in the winter semester 2020/2021. They apply to all students who commence their studies in the Master Physics programme after these regulations come into force.

(2) Students who began their studies in the Master Physics program before winter semester 2020/21 and have not yet completed them will be examined during a transitional period until September 30, 2024, according to the examination regulations of June 12, 2013 (Mittbl. 20/2013, p. 2097) which have been valid for them before. On application by 30 September 2024 at the latest, they will be examined in accordance with these examination regulations.

Kassel, the

The Dean of the Department of Mathematics and Natural Sciences

Prof. Dr. Maria Specovius-Neugebauer

Attachment: Study and examination plan for the Master of Science Physics

Module name	PMP 1 Advanced Lab (Master)
Type	Compulsory
Competencies	Students ... can overlook the function of complex measuring devices and operate them safely. ... can adjust complex measurement setups and optimize them for the measurement. ... know strategies to ensure that measurements in complex measurement processes are error-free. ... have gained experience with the search for errors and disturbances in complex measuring processes. ... master the evaluation of measured values, calculation of physical quantities from the measured values and calculation of the error for the measurement results, even for more complex measurements. Students have acquired integrated key competences in the following areas: Methods: They can write a report on Their measurements, presenting the basics, experimental setup, experimental results and conclusions according to scientific criteria.
Course types	Pi (6 SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	None
Student workload	Presence: 90 h, self-study: 90 h, total: 180 h
Compulsory projects or exercises	Successful execution of all experiments including colloquium and report on each experiment
Module Examination	None
Credits	6 c (of which 1 c for integrated key competences)

Module name	PMP2 Experimental Physics Seminar
Type	Elective
Competencies	Students ... are able to find independently research literature on a given, current topic from modern experimental physics, which is still partly the subject of research. ... are able to independently acquire a current field of knowledge. ... can structure and give a lecture on a complex topic of modern experimental physics in such a way that a physically educated audience can easily follow the lecture. By structuring the lecture they can also interest the audience in a complex special topic. Integrated key competences: Communication Competence ... are able to create an appealing presentation. ... are able to lead a scientific discussion (on their own topic as well as on the topics of the other seminar participants). ... ar good in German and English technical language in free speech
Course types	S 2 SWS ("advanced seminar")
Requirements for module participation	None / none
Prerequisites for Admission to Examination	attendance time: 2h x 15 = 30 h, self-study: 120 h, total = 150 h
Student workload	None
Compulsory projects or exercises	None
Module Examination	Seminar lecture with scientific discussion (total 30 - 60 min)
Credits	5 C (including 2 C for integrated key competences)

Module name	PMP 3 Theoretical Physics Seminar
Type	Compulsory
Competencies	Students ... are able to find independently research literature on a given, current topic from modern theoretical physics, some of which is still the subject of research. ... can structure and deliver a lecture on a complex topic of modern theoretical physics in such a way that a physically educated audience can easily follow the lecture. By structuring the lecture they can also interest the audience in a complex special topic. Students have acquired integrated key competences in the following areas: Communication: They are able to create an appealing presentation on a theoretical topic. They are good in English technical language in free speech. They are able to lead a scientific discussion (on Their own topic as well as on the topics of the other seminar participants). Methods: They will be able to work on a current field of knowledge independently.
Course types	S (2 SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	None
Student workload	attendance: 75 h, self-study: 75 h, total: 150 h
Compulsory projects or exercises	None
Module Examination	Seminar lecture with scientific discussion (total 30-60 min)
Credits	5 c (including 2 c for integrated key competences)

Module name	PMP 4 Specialization in scientific area
Type	Compulsory
Competencies	Students ... can familiarise themselves with a new field of research independently. ... can get an overview of the technical literature on a research project. ... are able to recognise, assess and integrate future problems, technologies and scientific developments in their work due to the professional depth and breadth of the acquired competences. ... can, in the case of experimental work, oversee the function of complex measuring equipment, operate it safely and adjust complex measuring setups and optimize them for the measurement. ... can use and further develop computer-controlled experiments and data acquisition. ... are, in the case of theoretical work, able to further develop parts of complex computer programs and incorporate new functions into the programs. ... have gained experience in the search for errors in the development of computer programs in theoretical physics. ... can use computer algebra to solve complex theoretical problems in the case of theoretical work. Students have acquired integrated key competences in the following areas: Communication: They can communicate in German and English within the team without any problems. They can integrate themself into a research team and also work in international research groups. They have acquired social skills to integrate themself into an (international) research or development team. Methods: They are able to familiarize themself with the measurement methods or theoretical concepts of a research area. Organization: They are able to design devices in cooperation with technicians and engineers, which take over certain functions in a complex measuring process. They are familiar with strategies to ensure that the measurement works without errors in complex measurement processes and have experience in finding errors and faults in complex measurement processes.
Course types	individual support (approx. 1h per week)
Requirements for module participation	None
Prerequisites for Admission to Examination	None
Student workload	450 hours of work, mainly at the university (laboratory/workplace)
Compulsory projects or exercises	None
Module Examination	Seminar lecture with scientific discussion (total 30-60 min)
Credits	15 c (including 5 c for integrated key competences)

Module name	PMP 5 Methodological Expertise and Project Planning
Type	Compulsory
Competencies	Students ... can get an overview of the technical literature of a research project. ... have mastered the operation of complex measuring equipment or can use extensive computer programs to solve problems numerically. ... are able to recognise, assess and integrate future problems, technologies and scientific developments in their work due to the professional depth and breadth of the acquired competences. ... have gained a deep understanding of mathematical principles and their application to experimental observations. Students with experimental focus ... can overlook the functions of complex measurement setups, adjust them, optimize them for the measurement and operate them safely. ... know strategies to ensure that measurements in complex measurement processes are error-free and have experience in troubleshooting complex measurement processes. Students with a theoretical focus ... can use complex computer programs from theoretical physics to answer open questions of current research. ... are able to further develop parts of complex computer programs and incorporate new functions into the programs and are familiar with strategies for testing whether complex computer programs function without error. ... have gained experience in searching for errors in the development of computer programs in theoretical physics ... can correctly estimate the accuracy of the calculated results with regard to the approximations made and numerical methods used. ... can use computer algebra to solve complex theoretical problems. Students have acquired integrated key competences in the following areas: Communication: They can integrate themself into research teams and also work in internationally composed groups. can give a scientific lecture and present their own results in the context of the current state of science in the field. can create a poster presentation and discuss their results scientifically. They can communicate in a team easily in German and English. They can deal with critical questions in a scientific discussion and present their own results in a well-founded way. Methods: They act atcording to the rules of good scientific practice. They can independently familiarize Themself with a new field of research. They are able to familiarise Themself with the measuring methods or theoretical concepts of a research area. Organisation: They have prepared Themself to take on management responsibility. They are able to work independently and know how to organise and implement complex projects. In cooperation with technicians and engineers, they are able to design devices that take over certain functions in a complex measuring process.
Course types	individual support (approx. 1h per week)
Requirements for module participation	None
Prerequisites for Admission to Examination	None
Student workload	450 hours of work, mainly at the university (laboratory/workplace)
Compulsory projects or exercises	None
Module Examination	Seminar lecture with scientific discussion (total 30-60 min)
Credits	15 c (including 5 c for integrated key competences)

Module name	PMWT 1 Theoretical Solid State Physics
Type	Elective
Competencies	Students ... are able to mathematically formulate and solve concrete tasks from theoretical solid state physics. ... can use suitable computational techniques to solve problems. ... are able to find and execute analytical solutions for physical problems. ... are able to make suitable approximations in the approach to a solution. ... are familiar with the processing of example tasks from theoretical solid state physics. ... know the prominent examples from theoretical solid state physics and are able to solve selected examples with an appropriate degree of difficulty. ... are able to independently expand their knowledge in theoretical solid state physics and to obtain suitable literature for this purpose.
Course types	VL (4 SWS), Ü (2 SWS)
Prerequisites for Admission to Examination	Compulsory projects or exercises
Requirements for module participation	None
Student workload	attendance: 6h x 15 = 90h, self-study: 150h, total: 240h
Compulsory projects or exercises	Successful participation in the exercises
Module Examination	Written examination (2-3 hours) or oral examination (30 min). Type of examination, date and duration will be communicated at the beginning of the course.
Credits	8 c

Module name	PMWT 2 Quantum Mechanics II
Type	Elective
Competencies	Students ... are able to mathematically formulate and solve concrete tasks from advanced quantum mechanics. ... can use suitable computational techniques to solve problems. ... are able to find and execute analytical solutions for physical problems. ... are able to make suitable approximations in the approach to a solution. ... are familiar with the processing of sample tasks from advanced quantum mechanics. ... know prominent examples from advanced quantum mechanics and are able to solve selected examples with an appropriate degree of difficulty. ... are able to independently expand their knowledge in advanced quantum mechanics and to obtain suitable literature for this purpose.
Course types	VL (4 SWS), Ü (2 SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	Compulsory projects or exercises
Student workload	Presence: 90 h, self-study: 150 h, total; 240 h
Compulsory projects or exercises	Successful participation in the exercises
Module Examination	Written examination (2-3 hours) or oral examination (30 min). Type of examination, date and duration will be communicated at the beginning of the course.
Credits	8 c

Module name	PMWT 3 Computational Physics
Type	Compulsory voting
Competencies	Students ... have a fundamental understanding of the numerical approach to problems of theoretical physics. ... know important numerical methods for solving problems in classical and quantum mechanics as well as statistical physics on the computer. ... have programming experience and the ability to use modern computer clusters. ... understand computer architectures and have experience in the performance evaluation of software. ... can transform theoretically formulated problems into a computer algorithm. ... have acquired practical experience in the execution of a small project in computer-oriented theoretical physics (mathematical formulation of the problem, implementation of the program, debugging of compiler or runtime errors, analysis of the results).
Course types	VL (3 SWS), Ü (1 SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	Compulsory projects or exercises
Student workload	attendance: 4h x 15 = 60h, self-study: 90h, total: 150h
Compulsory projects or exercises	Successful participation in the exercises
Module Examination	Development of a computer program for the numerical solution of a simple problem of physical or numerical interest from the topics covered in the lecture. Written report about algorithm including analysis of results or short lecture in a seminar including scientific discussion.
Credits	5 c

Module name	PMWT 4 Reviews of Modern Theoretical Physics
Type	Compulsory voting
Competencies	Students ... have a fundamental understanding of key microscopic physical phenomena in atomic, molecular, nanostructural and solid state physics. ... know important theories of theoretical physics both from a historical perspective and with regard to their significance for current research. ... understand central experimental observations that have led to the formulation of the respective theory. ... have the ability to describe phenomenological physical problems and to interpret theoretical results. ... can identify observables whose measurements are necessary for the description of a given physical phenomenon. ... can perform a critical analysis of theoretical predictions and a comparison with the experiment to validate the theoretical model.
Course types	VL (3 SWS), Ü (1 SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	Compulsory projects or exercises
Student workload	attendance: 60 h, self-study: 90 h, total: 150 h
Compulsory projects or exercises	Successful participation in the exercises
Module Examination	Written examination (2 h) or oral examination (30 min). Type of examination, date and duration of the examination will be communicated at the beginning of the course.
Credits	5 c

Module name	PMWT 5 Advanced Methods in Theoretical Physics
Type of module	Optional compulsory module
Learning outcomes, competences	- Mastery of a wide range of methods of modern theoretical physics, including a sound overview of the most important universal and historical techniques and knowledge of the latest methods necessary for understanding current research literature. - Acquisition of the basic theoretical concepts for understanding complex systems (e.g. the many-body problem, disordered systems, fluctuations at finite temperature, dynamics, etc.). - Mastery of the advanced mathematical methods required for application in atomic, molecular, nanostructural and solid state physics. - Ability to identify the appropriate mathematical approach to a problem in advanced theoretical physics. - Understanding the goals and limitations of analytical methods compared to the numerical approach, ability to combine both approaches. - Ability to assess the quality of einertheoretical work and to link their predictions to experiments.
Course types	VL3 SWS, Ü1 SWS
Requirements for module participation	None
RequirementsRegistration for the exam	Compulsory projects or exercises
Student workload	attendance time: 4h x 15 = 60h, self-study: 90h, total = 150h
Compulsory projects or exercises	Successful participation in the exercises
Module Examination	Written examination (2 hours) or oral examination (30 min) Type of examination, examination date and duration will be communicated at the beginning of the course.
Credits	5 c

Module name	PMWE 1 Applied Semiconductor Physics
Type	Elective
Competencies	Students ... have acquired a thorough knowledge of basic semiconductor physics ... know the principles of electron transport in semiconductors ... know fundamental building blocks for electronic and optoelectronic components ... know the manufacture and operating principles of the main electronic and optoelectronic components, including quantum-effect based devices and integrated circuits ... are trained in the quantitative solution of practical problems Integrated key competences: Competence of Method: Training in the presentation of solutions at the blackboard in front of an audience
Course types	VL (3 SWS), Ü (1 SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	At least 60% of the exercises solved
Student workload	attendance: 60 h, self-study: 120 h, total: 180 h
Compulsory projects or exercises	Successful participation in exercises
Module Examination	Written examination (2-3 h) or oral examination (30 min). Type of examination, date and duration of the examination will be communicated at the beginning of the course.
Credits	6 c (incl. 1 C for international key competences)

Module name	PMWE 2 Semiconductor Laser
Type	Elective
Competencies	Students ... have acquired a thorough knowledge of the fundamentals of laser physics ... understand the principles of semiconductor lasers including static and dynamic properties ... know the quantum mechanical origin of the most important laser properties ... get a quantitative understanding of the properties and specifications of components ... get an overview of components, manufacturing and application-driven designs ... get an overview of the most important types of semiconductor lasers and their applications ... are involved in current research and development of semiconductor lasers
Course types	VL (3 SWS), S (1 SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	Compulsory projects or exercises
Student workload	attendance: 60 h, self-study: 120 h, total: 180 h
Compulsory projects or exercises	Successful participation in the seminar
Module Examination	Written examination (approx. 2 h) or oral examination (30 min). Type of examination, examination date and duration will be communicated at the beginning of the course
Credits	6 c (incl. 1 C for international key competences)

Module name	PMWE 3 Ultrashort Laserpulses and their Applications
Type	Elective
Competencies	Students ... have exemplarily familiarized themselves with a selected special field of experimental physics and are able to start work in an experimental research group in short-term laser physics. ... have an overview of the established knowledge in the special field. ... know significant developments in short time laser physics from the last years or decades and have an idea of current unsolved problems in the field. ... know the experimental techniques used in short-time laser physics and can judge which techniques are suitable for measuring certain physical quantities. ... know the advantages and disadvantages of individual experimental techniques and know how the different techniques complement each other. ... know the relevant models and approximations for the description of physical phenomena in short-time laser physics. ... are aware of the limitations of the models used. ... know the basics of generation, propagation, manipulation and characterization of ultrashort laser pulses in theory and the corresponding experimental setups. ... know current application areas with an understanding of the underlying theory and for the corresponding experimental setups, as well as with a detailed understanding of the short pulse specific advantages for the respective areas
Course types	VL (2 SWS), VL (1 SWS), Pi (1 SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	None
Student workload	attendance: 60 h, self-study: 180 h, total: 240 h
Compulsory projects or exercises	None
Module Examination	Written examination (1-2 h) or oral examination (30 min). Type of examination, examination date and duration will be communicated at the beginning of the course.
Credits	8 c

Module name	PMWE 4 Surface Science
Type	Elective
Competencies	Students ... have exemplarily familiarized themselves with a selected special field of surface science and are able to start work in an experimental research group in surface science. ... have an overview of the established knowledge in surface science. ... know significant developments in surface science from the last years or decades and have an idea of current unsolved problems in the field. ... know the experimental techniques used in surface physics and can judge which techniques are suitable for measuring certain physical quantities. ... know the relevant models and approximations for the description of physical phenomena in surface science ... can present basic principles and current research results in surface science in a lecture in English. Students have acquired integrated key competences in the following areas: Methods: They know the advantages and disadvantages of individual experimental techniques and know how the different techniques complement each other. They are aware of the limitations of the models used.
Course types	S (2 SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	None
Student workload	Presence: 30 h, self-study: 90 h, total:120 h
Compulsory projects or exercises	None / None
Module Examination	Seminar talk (30-45 minutes).
Credits	4 c

Module name	PMWE 5 Molecular Physics and Spectroscopy I
Type	Elective
Competencies	Students ... have become acquainted with a selected special field of experimental physics in an exemplary manner and are able to start work in an experimental research group in molecular physics. ... have an overview of the established knowledge in the special field. ... know significant developments in molecular physics from the last years or decades and have an idea of current unsolved problems in the field. ... know the experimental techniques used in molecular physics and can judge which techniques are suitable for measuring certain physical quantities. ... know the advantages and disadvantages of individual experimental techniques and know how the different techniques complement each other. ... know the relevant models and approximations for the description of physical phenomena in molecular physics and are aware of the limits of the models used. ... have basic knowledge of methods to generate reactive, short-lived molecules ... have basic knowledge of rotational and vibrational spectroscopy
Course types	VL (2 SWS), Ü (1SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	Compulsory projects or exercises
Student workload	attendance: 60 h, self-study: 120 h, total: 180 h
Compulsory projects or exercises	Successful participation in exercises
Module Examination	Written examination (1-2 h) or oral examination (30 min). Type of examination, examination date and duration will be communicated at the beginning of the course.
Credits	6 c

Module name	PMWE6 Nano Scale Quantum Optics
Type	Elective
Competencies	Students

	… will have acquired a thorough knowledge about quantum optics applicable to the nanoscale … will be able to describe experiments which are depicting key concepts of quantum optics ... will know different experimental platforms to perform quantum optics experiments with special focus on the nano scale ... are able to present and discuss research work … will be able to understand and apply experimental and theoretical concepts from quantum information processing Integrated key competencies: Methodic competency: Students have the ability to apply their knowledge and understanding, and problem solving abilities to actual research work
Course types	VL 3 SWS, S 1 SWS
Requirements for module participation	None
Prerequisites for Admission to Examination	None
Student workload	Presence : 60 h, self-study : 120 h, total = 180 h
Compulsory projects or exercises	exercises, seminar lecture
Module Examination	Written examination (1-2 h) or oral examination (30 min). Type of examination, examination date and duration will be communicated at the beginning of the course.
Credits	6 C (1 C int. key competences)

Module name	PMWE 7 Seminar Astrophysics and Cosmology
Type	Elective
Competencies	Students ... are able to independently find literature on a given current topic in astrophysics. ... are able to lead a scientific discussion (on their own topic as well as on the topics of the other seminar participants). Students have acquired integrated key competences in the following areas: Communication: They are able to present the chosen topic in an understandable way in the form of a lecture. They have a good command of the German or English technical language in free speech.
Course types	S (2 SWS)
Requirements for module participation	None
Prerequisites for Admission to Examination	None
Student workload	attendance: 30 h, self-study: 90 h, total: 120 h
Compulsory projects or exercises	None
Module Examination	Seminar lecture with scientific discussion (total 30 - 60 min)
Credits	5 c (including 2 c for integrated key competences)

Module name	PMWE 8 General Theory of Relativity and Cosmology
Type	Elective
Competencies	Students ... know the special theory of relativity in 4-component notation ... have mastered tensor analysis and algebra. ...can apply Einstein's field equations to experimental results. ... know the standard model of cosmology ... have an overview of other cosmological models. ... know the interpretation of the Friedmann equations.
Course types	V (2 SWS), Ü (1 SWS)
Prerequisite module participation	None
Prerequisite Examination performance	None
Student workload	Presence: 45 h, self-study 30 h, total: 75 h
Compulsory projects or exercises	Successful participation in the exercises
Module Examination	Written examination (2 h) or oral examination (30 min). Date and duration of the examination will be announced at the beginning of the course.
Credits	*5 c*

Module name	PMWE 9 Molecular Physics and Spectroscopy II
Type	Elective
Competencies	Students ... have become acquainted with a selected special field of experimental physics in an exemplary manner and are able to start work in an experimental research group in molecular physics. ... have an overview of the established knowledge in the special field. ... know significant developments in molecular physics from the last years or decades and have an idea of current unsolved problems in the field. ... know the experimental techniques used in molecular physics and can judge which techniques are suitable for measuring certain physical quantities ... know the advantages and disadvantages of individual experimental techniques and know how the different techniques complement each other. ... know the relevant models and approximations for the description of physical phenomena in laboratory spectroscopy ... are aware of the limitations of the models used. ... have basic knowledge of methods for generating reactive molecules ... have basic knowledge of rotational and vibrational spectroscopy
Course types	VL (2 SWS), Ü (1SWS)
Prerequisite module participation	None
Prerequisites for Admission to Examination	Successful participation in exercises
Student workload	attendance: 60 h, self-study: 120 h, total: 180 h
Compulsory projects or exercises	Seminar lecture with scientific discussion (total 30-60 min)
Module Examination	Examination performance: oral examination (30 min), examination dates will be arranged individually and communicated to the examination office
Credits	6 c

Module name	PMWE 10 Physics with Synchrotron Radiation
Type	Elective
Competencies	Students ... acquire basic knowledge of the properties of synchrotron radiation and its applications ... know methods of material analysis using synchrotron radiation ... have acquired basic knowledge of synchrotron-based lithography processes
Course types	VL 2 SWS
Prerequisite module participation	None
Prerequisites for Admission to Examination	None
Student workload	attendance: 30 h, self-study: 60 h, total: 90 h
Compulsory projects or exercises	None
Module Examination	Orally (30 min.) or in writing (1-2 h). Date and duration of the examination will be communicated at the beginning of the course.
Credits	3 C

Module name	PMWE11 Thin Film Physics
Type	Elective
Competencies	Students ... have acquired a basic knowledge of the deposition and characterization of thin films ... know the electrical, mechanical and magnetic properties of thin films and techniques for their manipulation (with emphasis on magnetic properties) ... know magnetic coupling phenomena in thin films and their applications ... know fundamental effects in magnetic nanostructures and their applications
Course types	VL 2 SWS
Prerequisite module participation	None
Prerequisites for Admission to Examination	None
Student workload	attendance time 30 h, self-study 60 h, total = 90 h
Compulsory projects or exercises	None
Module Examination	Oral (30 min) or written (1-2 h) examination. Type, time and duration of the m-examination will be announced at the beginning of the lecture
Credits	3 C

Module name	PMWE 12 Advanced Nano Scale Quantum Optics
Type	Elective
Competencies	Students … will have acquired an advanced knowledge about quantum information processing … will be able to describe sophisticated experiments which are depicting key concepts of quantum information processing ... will know different experimental platforms to perform quantum optics experiments with special focus on quantum information processing ... are able to simulate and verify research work … will be able to extend and develop advanced experimental and theoretical concepts from quantum information processing Integrated key competencies: Methodic competency: Students have the ability to apply their knowledge and understanding to develop now ideas in quantum information processing and quantum optics
Course types	VL 3 SWS, S 1 SWS
Requirements for module participation	None
Prerequisites for Admission to Examination	None
Student workload	Contact time: 60 h, Independent studies: 120 h, Summe = 180 h
Compulsory projects or exercises	exercises, seminar lecture
Module Examination	Written examination (1-2 h) or oral examination (30 min). Type of examination, examination date and duration will be communicated at the beginning of the course.
Credits	6 C (1 C int key competences)

Module name	PMWS 1 Additive Key Competencies
Type	Elective
Competencies	Students ... have acquired skills that broaden the spectrum of competences acquired in the field and are important for a later professional life, for example in scientific ethics, law, economics, English technical language, journalism, social and personal competence, communication skills, analytical thinking, personnel management, project management, committee and team work.
Course types	One or more courses, which are listed in the University of Kassel's course catalogue under the heading "Additive Key Competences Interdisciplinary" and updated for each semester. In consultation with the lecturer offering the course, 1 to 6 credits can be awarded for each course. Participation in committees of the University of Kassel (e.g. faculty council, student council, study committee, AStA) as well as working as a student assistant in self-administration, to support teaching or to advise students (e.g. as a tutor) can also be credited as a course.
Prerequisite module participation	None
Prerequisite Examination performance	According to the specifications of the offering lecturers or areas.
Student workload	90 h - 360 h, depending on the chosen event
Compulsory projects or exercises	Proof of academic achievements in all attended courses according to the specifications of the offering lecturers or departments.
Module Examination	The module is evaluated as a whole with "Passed" or "Not Passed". In order to be assessed as "passed", the study or examination achievements of each individual, selected course must have been assessed by the providers/lecturers at least with "passed".
Credits	3 to 12 c

Module name	PMWS 2 Non-physical Elective Moduls
Type	Elective
Competencies	From the occupied module
Course types	From the occupied module
Requirements for module participation	None
Student workload	150 h to 360 h
Compulsory projects or exercises	From the occupied module
Prerequisites for Admission to Examination	From the occupied module
Module Examination	From the occupied module
Credits	5 to 12 c

Module name	PMWS 3 Occupational Internship
Type	Elective
Competencies	Students ... have gained an insight into the professional world by working in a company or institution outside the university where physicists are employed. ... have acquired job-specific skills depending on the chosen internship location. Students have acquired integrated key competences in these areas: Communication: They have integration and team skills. Methods: They are able to write a practice report independently. Organization: They can meet targets.
Course types	Pe
Requirements for participation	None
Student workload	Presence: 240 h (6 weeks) or 360 h (9 weeks)
Compulsory projects or exercises	seminar presentation 30 min or internship report approx. 5-10 pages
Prerequisites for Admission to Examination	None
Module Examination	None
Credits	8 c for 6 weeks or 12 c for 9 weeks (of which 4 c for integrated key competences)

Module name	PMP 6 Master's Degree Module
Type	Compulsory
Competencies	Students ... can independently familiarize themselves with a new field of research. ... are proficient in the operation of complex measuring equipment or can use extensive computer programs to solve problems numerically. ... are able to recognise, assess and integrate future problems, technologies and scientific developments in their work due to the professional depth and breadth of the acquired competences. ... have gained a deep understanding of mathematical principles and their application to experimental observations. ... are able to design and structure a research project of 6 months duration. ... can systematically analyse the research results and correctly assess the knowledge gained for the progress of science. ... can present the research results they have achieved in writing in their Master's thesis and orally in a lecture. ... reflect critically on their own research results and are able to defend their findings to a scientific audience. Students with experimental focus ... can overlook the functions of complex measuring equipment and operate it safely. ... can adjust complex measurement setups and optimize them for the measurement. ... have experience in troubleshooting in complex measuring processes. Students with a theoretical focus ... can use computer algebra to solve complex theoretical approaches and use complex computer programs from theoretical physics to answer open questions of current research. ... are able to further develop parts of complex computer programs and incorporate new functions into the programs. ... know strategies for testing complex computer programs ... can correctly estimate the accuracy of the calculated results with regard to the approximations made and numerical methods used. Students have acquired integrated key competences in the following areas: Communication: They can work in an international team. They can communicate in German and English without any problems. They have acquired social skills that enable them to integrate into a research or development team. They can give a scientific lecture and present their own results in the context of the current state of science in the field. They can also deal with critical questions in a scientific discussion and present their own results in a well-founded way. They can create a poster presentation and discuss their results scientifically. Methods: They act according to the rules of good scientific practice. They are able to familiarize themself with the measuring methods or theoretical concepts of a research area. They can obtain an overview of the specialist literature on a research project and write a scientific paper. Organization: They are able to design devices in cooperation with technicians and engineers, which are to take over a certain function in a complex measuring process. They are able to work independently in a scientific project and can organise, carry out and manage complex projects and have prepared themself to take on management responsibility.
Course types	Individual support
Requirements for module participation	Advanced Lab (Master), Experimental Physics Seminar, Theoretical Physics Seminar, Spezialisation in scientific area, Methodological Expertise and Project Planning
Prerequisite Examination performance	None
Student workload	900 h
Compulsory projects or exercises	None
Module Examination	Master thesis
Credits	30 c (including 5 c for integrated key competences)