Study and Examination Regulations for the Master's degree programme in Physics of the Department of Physics at Freie Universität Berlin

Preamble

On the basis of Section 14 (1) Sentence 1 No. 2 of the Basic Division Ordinances (laboratory model) of Freie Universität Berlin dated 27 October 1998 (FU-Mitteilungen [Gazette of Freie Universität Berlin] No. 24/1998), the Department Council of the Department of Physics at Freie Universität Berlin adopted the following Study and Examination Regulations for the Master's degree programme in Physics of the Department of Physics at Freie Universität Berlin on 12 February 2020: [1]

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Appendices

[1] These Regulations have been approved by the Executive Board of Freie Universität Berlin on 16/03/2020.

§ 1
Area of application

(1) These Regulations stipulate the objectives, content and structure of the Master's degree programme in Physics of the Department of Physics at Freie Universität Berlin (Master's degree programme), and, in addition to the Framework Study and Examination Regulations of Freie Universität Berlin (RSPO), the requirements and procedures for study and examination performance (attainments) within the Master's degree programme.

(2) This is a consecutive Master's degree programme in accordance with Section 23 (3) No. 1 a) of the law regulating higher education institutions in Berlin (Berlin Higher Education Act – BerlHG) in the amended version of 26 July 2011 (Law and Ordinance Gazette (GVBI. p. 378), most recently amended on 2 February 2018 (GVBI. p. 160), which is research-oriented and offered on a bilingual basis (English and, following consultation, German as well).

Section 2
Qualification aims

(1) Graduates of the Master's degree programme have profound specialist knowledge and are proficient in scientific methods in Physics and related subject areas, depending on the students' choices. Graduates have specialised knowledge in fields of modern experimental and theoretical physics and thorough skills in physics methodology. They are familiar with the current state of research in one of the core modern research areas of the Department of Physics and are capable of penetrating deeper into issues in physics in independent scientific work, to order this knowledge and to present it in lectures or texts. In particular, as generalists in science they are able to work successfully on issues in a wide range of fields of science and technology.

(2) Graduates of the programme have basic skills in scientific research, in reading and writing scientific texts in the English language and in lecture and presentation techniques. They have a modern approach to gender and diversity issues and have gained skills in teamwork, communication and the ability to apply their knowledge in other contexts. In addition they have basic knowledge in the fields of project management and project planning in research. They can apply these skills in independent work, present their planning in writing, giving reasons for it and defending it in the face of critical questions. The graduates are capable of scientific thinking, critical judgement, responsible action, communication and cooperation. In some cases the graduates may also have skills in related scientific, interdisciplinary, cross-disciplinary or complementary professional preparation disciplines. Participants on the German-French Master's double degree programme with École Polytechnique de Paris also have intercultural language and management skills.

(3) The professional field for graduates of the Master's degree programme is wide-ranging, extending from fundamental or industrial research to application-related development and technical marketing, planning, examination and management tasks in industry or administration. Successful completion of the Master's degree programme qualifies the graduate to embark on doctoral studies in compliance with the relevant admissions requirements, in particular in scientific or technological fields.

Section 3
Programme content

(1) The Master's degree programme equips the students with a deepened and expanded

specialist knowledge of physics and knowledge of related disciplines, depending on the students‘ choices. The Master’s degree programme focuses on advanced concepts, current methodology and topics and methods of current research. The study programme enables the students to carry out independent work in a special field of physics, in particular the scientific areas focused on by the physics department such as nanophysics, surface physics, biophysics, ultrafast physics or the physics of complex quantum systems, as well as the rules of good scientific practice and the opening up of innovative issues in research laboratories or theoretical working groups, for example.

(2) Gender and diversity aspects are taken into account in an appropriate way in the Master’s degree programme, wherever this seems sensible from a scientific and/or didactic or educational point of view in relation to the topic, in particular in the history of physics. In addition, regular events with relevant content are provided. Further soft skills beyond the purely scientific in the sense of Section 2 (2) are gained principally through independent work on current issues and guided research work.

Section 4
Academic advisory centre and departmental advisory service

(1) General student advisory services are provided by the central academic advisory centre and the psychological counselling service of Freie Universität Berlin.

(2) In addition, the departmental advisory service comprising all full-time lecturers in the Physics department of Freie Universität Berlin supports all students throughout the degree programme with subject-specific individual advice, in particular about how to structure and carry out their studies and the examinations, about scientific work and opportunities for specialisation and the planning for participating in the Master’s double degree programme. There is at least one student assistant on hand as well to provide these course advising services.

(3) In addition a student’s departmental advisory service is provided in all semesters (throughout the entire programme duration).

Section 5
Examining Board

The Examining Board for the Master’s degree programme, as appointed by the Department Council of the Department of Physics at Freie Universität Berlin, is responsible for organising examinations and other tasks as listed in the RSPO.

Section 6
Standard study period

The standard study period for the Master’s degree programme is four semesters.

Section 7
Structure and organisation; credit points allocation

(1) It is required to obtain 120 credit points (CP) in total. The Master's degree programme comprises

1. an advanced phase worth 60 CP, of which 15 CP in the compulsory area, 20 CP in the compulsory elective area and 25 CP in the elective area

as well as

2. a research phase worth 60 CP, of which 30 CP are allocated to the Master's thesis with accompanying seminar.

(2) The advanced phase must be taken as follows:

1. Compulsory area: in the compulsory area comprising 15 CP, the following modules must be taken:

- Module: Advanced Laboratory Course for Master Students (10 CP) and
- Module: Selected Topics in Physics (5 CP).

2. Compulsory elective area: in the compulsory elective area comprising 20 CP, two modules comprising 10 CP each must be taken.

a. At least one of the following modules from the field of theoretical physics must be selected:

- Module: Advanced Quantum Mechanics (10 CP),
- Module: Statistical Physics and Thermodynamics (10 CP),
- Module: Advanced Statistical Physics (10 CP) and/or
- Module: Quantum Field Theory and Many-Body Physics (10 CP).

b. If the student has not selected two modules from the field of theoretical physics, one of the following modules from the field of experimental physics must be selected:

- Module: Advanced Solid State Physics (10 CP),
- Module: Advanced Atomic and Molecular Physics (10 CP) or
- Module: Advanced Biophysics (10 CP).

3. Elective area: in the elective area comprising 25 CP, modules totalling 25 CP altogether must be selected and taken.

a. The following modules from central research fields of the Physics department may be taken:

- Module: Theoretical Solid State Physics (10 CP),
- Module: Advanced Theoretical Biophysics (8 CP),
- Module: Nanophysics (5 CP),
- Module: Ultrafast Spectroscopy and Nonlinear Optics (5 CP),
- Module: Spectroscopy with Synchrotron Radiation (8 CP),
- Module: Photobiophysics and Photosynthesis (5 CP),
- Module: Semiconductor Physics (5 CP),
- Module: General Relativity (5 CP) and/or
- Module: History of Physics (5 CP).

b. In addition the following supplementary modules are also offered:

- Module: Advanced Topics in Theoretical Condensed Matter Physics (5 CP),
- Module: Special Topics in Magnetism (5 CP),
- Module: Special Topics in Molecular Physics (5 CP),
- Module: Special Topics in Molecular Biophysics (5 CP),
- Module: Advanced Astronomy and Astrophysics (12 CP),
- Module: Modern Methods in Theoretical Physics A (5 CP),
- Module: Modern Methods in Theoretical Physics B (8 CP),
- Module: Modern Methods in Theoretical Physics C (10 CP),
- Module: Modern Methods in Experimental Physics A (5 CP),

- Module: Modern Methods in Experimental Physics B (8 CP) and/or
- Module: Modern Methods in Experimental Physics C (10 CP).

The modules in the elective area are offered in an irregular sequence. At least seven of the modules listed under a) and b) in the elective area will be held in each academic year. Additional modules from the compulsory elective area may also be taken in the elective area; supplementary modules from non-physics subjects which are related to the major subject may also be taken on application to the Examining Board, giving reasons. The application must include an explanation of how the module relates to the overall qualification aim. The relevant Examining Board will make a decision on the application.

Modules which are identical to or very similar in content to a module which has already been taken and recognised as part of a degree in a previous study programme may not be selected for the Master's degree programme.

(3) In the research phase, the students first take the parallel modules "Scientific Specialisation" (15 CP) and "Methodology and Project Planning" (15 CP). Immediately afterwards, the Master's thesis with accompanying seminar worth 30 CP will be taken. Students will be admitted to the research phase on application when they have

1. successfully taken the module "Advanced Laboratory Course for Master Students" (10 CP) in accordance with paragraph 2 no. 1 and a module of theoretical physics from the compulsory elective area comprising 10 CP in accordance with paragraph 2 no. 2 (a) and further modules of the Master's degree programme in accordance with paragraph 2 comprising at least 25 CP, and
2. submitted their application for admission to the Master's thesis.

If the Examining Board approves, the research phase may also be taken externally in a suitable company or scientific institution, on condition of scientific supervision by a lecturer who is an authorised examiner for the Master's degree programme.

(4) The module language in the Master's degree programme is English. Written reports, records, examinations and the Master's thesis may be presented in German if the relevant lecturer agrees. If none of the participating students objects, individual events may be held in German.

(5) The module descriptions for the Master's degree programme in Appendix 1 provide information on admission requirements, content and qualification objectives, types of teaching and learning, workload, types of active participation, examinations to be taken during the course, regular participation obligations for types of teaching and learning, credit points assigned to each module, and standard duration and the frequencies of modules offered.

(6) A sample degree programme table in Appendix 2 under 2.1. provides information on the recommended course of study for the Master's degree programme.

Section 8
Master's double degree programme with École Polytechnique de Paris

(1) Qualified students on the Master's degree programme have the opportunity of taking a Master's double degree programme from the start of a winter semester, which the Department of Physics at Freie Universität Berlin offers in collaboration with École Polytechnique de Paris, France (École Polytechnique). A joint admissions committee decides on the admission of candidates to the Master's double degree programme. Freie Universität Berlin and École Polytechnique each nominate two members to the joint admissions committee. The members nominated by Freie Universität Berlin must be authorised examiners for the Master's degree

programme in Physics. The application deadline is 30 April of each year. Application for the Master's double degree programme usually takes place after the first study semester. Applicants may submit a preliminary request for participation in the Master's double degree programme alongside their application to the Master's degree programme. The selection committee also decides on such preliminary requests. It may declare provisional acceptance on condition of admission to the Master's degree programme and the attainments to be achieved in the first semester. The Examining Board will announce the acceptance criteria in good time and in an appropriate form.

(2) The Master's double degree programme comprises an advanced phase at Freie Universität Berlin and a research phase at École Polytechnique; it comprises a total of 120 CP, of which 30 CP are allocated to the Master's thesis and the accompanying seminar.

(3) In the advanced phase, students complete all modules of the compulsory area in accordance with Section 7 (2) no. 1. In the compulsory elective area in accordance with Section 7 (2) no. 2, the module "Statistical Physics and Thermodynamics" (10 CP) must be selected and completed if the student has not already completed this module or an equivalent module in his/her Bachelor's degree programme; apart from this, Section 7 (2) no. 2 applies to the selection and completion of modules in the compulsory elective area. The modules of the elective area are to be selected and completed in accordance with Section 7 (2) no. 3.

(4) In the research phase the students complete an M2 programme at École Polytechnique including a Master's thesis with accompanying seminar, whereby a continuous research phase of at least 12 months is to be completed. The M2 programme "Nanoscience" is recommended. Compulsory modules and modules of this programme comprising 30 CP are taken in this M2 programme. Instead of the M2 programme "Nanoscience", other M2 programmes in the field of physics offered by École Polytechnique may be selected.

(5) The module descriptions for the Master's degree programme in Appendix 1 provide information on admission requirements, content and qualification objectives, types of teaching and learning, workload, types of active participation, examinations to be taken during the course, regular participation obligations for types of teaching and learning, credit points assigned to each module, and standard duration and the frequencies of modules offered. For the attainments to be achieved in the scope of the modules in the research phase, students are referred to the regulations at our partner university, École Polytechnique.

(6) A sample degree programme table in Appendix 2 under 2.2. provides information on the recommended course of study for the Master's double degree programme.

Section 9
Teaching and learning units

(1) The following types of lecture are provided in the Master's degree programme:

1. Lectures (L) give either an overview of a larger area of the subject and its methodological/theoretical principles or knowledge of a specialised subject area and related research issues. The primary teaching unit is the lecture by the relevant teaching staff.

2. Compulsory elective lectures (CEL) are intended to give an overview of an area of the subject and its methodological/theoretical principles or knowledge of a specialised subject area and related research issues. The principle teaching unit is the lecture by the relevant teaching staff.

3. Practice seminars (PS) are intended to convey application-oriented knowledge of a defined subject area and enable the students to gain practical skills, to work on a task independently, present the results and to discuss them critically. The principle work form is the solving of practice tasks. The teaching staff guides and monitors the activities.

4. Seminars (S) are intended to give knowledge of a defined subject area and to develop the ability to work independently on an issue, to present the findings and to discuss them critically. The principle work forms are seminar discussions on the basis of teaching materials, preparatory reading (specialist literature and sources), work assignments and group work.

5. Practicals (P) are intended to enable students to work independently on issues and possible solutions on selected objects with appropriate methods and to learn practical and analytical skills. Under guidance, the students gain experience in applying the scientific knowledge of the subject and the methodology which they have learnt and can test their suitability for particular professional fields. The teaching units which may be part of a practical give the opportunity to examine the teaching content of the practical, to clear up any confusion and to reflect on practical experience.

6. Project work (PW) is intended to enable each student to gain active practical skills, taking into account their individual strengths and weaknesses. The students work independently on an internal or external project over a fixed period. The principle teaching unit is supervision of the project planning and implementation.

(2) The types of teaching and learning under Section 1 may be implemented in blended learning arrangements. Learning conducted in person is linked with electronic Internet-based media (E-learning). Selected teaching and learning activities are offered are offered through central Freie Universität Berlin E-learning applications, which students may use individually, independently as part of a group and/or while supervised. Blended learning can be used in the implementation phase (exchange and discussion of learning objects, solving tasks, intensification of communication between learners and teachers) or in the follow-up phase (monitoring of learning success, transfer support).

Section 10
Master's thesis

(1) The Master’s thesis is intended to demonstrate that the student is capable of working independently on an issue in the field of theoretical or experimental physics at an advanced scientific level using scientific methods and to present the findings in an appropriate form, to place them in their scientific context and to document them.

(2) Students are admitted to the Master’s thesis on application. The application for admission to the Master’s thesis is to be submitted to the Examining Board simultaneously with the application for admission to the research phase in accordance with Section 7 (3) clause 3. Admission to the Master’s thesis is not possible if the student has irrevocably failed to achieve the required attainment or has irrevocably failed the examination or is in a pending examination procedure at another university in the same programme of studies or in a module which is identical to or comparable with a module to be taken in the Master’s degree programme and for which the grade is to be included in the overall grade.

(3) The application must include a statement that none of the cases according to paragraph 2 clause 3 applies to the applicant. The relevant Examining Board will make a decision on the application. The application must also include written confirmation by an authorised examiner of

his/her willingness to take on the supervision of the Master's thesis. If not, the Examining Board will appoint a supervisor. The students have the opportunity to suggest their own topic; the right to take this topic is not guaranteed.

(4) The Examining Board sets a topic for the Master's thesis in agreement with the supervisor; the topic content must be coordinated with the modules of the research phase. The topic and scope of work must be such that they can be completed within the time permitted. Issue of the topic and compliance with the completion deadline must be recorded.

(5) The Master's thesis is to be completed within six months. It should comprise about 60 pages, including footnotes and bibliography.

(6) The date for the beginning of work on the Master's thesis is the date on which the topic was issued by the Examining Board. The topic may be returned once within the first four weeks and is considered not to have been issued in this case. Three bound copies and a digital copy in portable document format (PDF) of the Master's thesis are to be submitted by the completion deadline. The PDF file must not only contain the text graphically, but must also be machine-readable, and may not have any rights restrictions. When they submit their thesis, students must also confirm in writing that they have written the thesis personally and independently and have used no aids other than the sources and aids listed. One copy of the Master's thesis may be taken into the Institute's library on completion of the programme with the student's consent.

(7) Alongside the Master's thesis, a seminar is held in which each student holds one talk of approx. 30 minutes on the progress of his/her Master's thesis.

(8) The Master's thesis is to be evaluated by two authorised examiners appointed by the Examining Board. One of the two authorised examiners should be the supervisor of the Master's thesis. At least one of the authorised examiners should be a professor in the Department of Physics at Freie Universität Berlin.

(9) If the Examining Board agrees, the Master's thesis may also be carried out externally in a suitable company or scientific institution, on condition that the scientific supervision is carried out by an examiner as in paragraph 8.

(10) The Master's thesis of participants in the German-French Master's double degree programme at École Polytechnique is to be evaluated by an examiner from Freie Universität Berlin in accordance with paragraph 8 and by an examiner from École Polytechnique. It is possible to work on a thesis simultaneously in collaborative research groups at École Polytechnique and at Freie Universität Berlin, if the topic selected is suitable.

(11) The Master's thesis is passed if the grade for the Master's thesis is at least "sufficient" (4.0).

(12) The accreditation of another assignment as a Master's thesis is permissible and can be applied for at the Examining Board. The prerequisite for such accreditation is that the examination conditions and the tasks involved in the assignment presented do not differ significantly with regard to quality, level, learning outcomes, scope and profile from examination conditions and the tasked effort for a Master's thesis as conducted in the Master's degree programme, which is an especial characteristic of the qualification profile for the Master's degree programme.

Section 11
Retaking examinations

(1) If a Master's thesis is not deemed sufficient to have passed, it may be repeated once more. Other examinations taken during a course of study may be repeated three times.

(2) Examinations in the form of a written examination passed with the grade “sufficient” (4.0) or better may be retaken once to improve the grade in a later examination, which is to take place at the beginning of the following semester at the latest. The better grade will be taken into account. It is not possible to improve the grade after a failed exam.

Section 12
Study abroad

(1) Students are recommended to take a period of study abroad. In the course of their studies abroad, students should complete attainments which can be credited as equivalent to the modules which they would have taken during the same period at Freie Universität Berlin.

(2) Before starting to study abroad, the student should reach an agreement with the chair of the Examining Board responsible for the degree programme and the relevant position at the university to be visited, covering the duration of the study period abroad, the attainments to be completed during the study period abroad which must be equivalent to the attainments in the Master’s degree programme and the credit points allocated to the attainments. Attainments which comply with the agreement will be credited.

(3) The second semester is recommended as a suitable time for a period of study abroad.

(4) Within the scope of the Master’s degree programme, students also have the opportunity to apply for a Master’s double degree programme in collaboration with École Polytechnique in accordance with Section 8.

Section 13
University degree

(1) The prerequisite for the award of the final degree is proof that the attainments required in accordance with Sections 7 and 10, or in accordance with Sections 8 and 10 for the Master’s double degree programme, have been achieved.

(2) The final degree cannot be awarded if the student has irrevocably failed to achieve the attainment or has irrevocably failed the examination or is in a pending examination procedure at another university in the same programme of studies or in a module which is identical to or comparable with a module to be taken in the Master’s degree programme and for which the grade is to be included in the overall grade.

(3) The application for confirmation of the final degree must include proof of the fulfilment of the requirements according to paragraph 1 and a statement that none of the cases according to paragraph 2 applies to the applicant. The relevant Examining Board will decide on the application.

(4) The grades for the examinations taken for the Master’s double degree programme in accordance with Section 8 of the Study Regulations at our partner university will be passed on by the responsible office in the form of an average grade and the grade for the Master’s thesis to the Examining Board at Freie Universität Berlin. The following grade conversion table applies:

French grading scale, partner university	Grading scale, Freie Universität Berlin
16, 17, 18, 19, 20	1.0
15	1.3

14	1.7
13	2.0
12.5	2.3
12	2.7
11.5	3.0
11	3.3
10.5	3.7
10	4.0
<10	>4.0 (deficient)

The overall grade is the arithmetic average from the overall grade for the part of the programme taken at Freie Universität Berlin comprising 60 CP and the part taken at École Polytechnique comprising 60 CP.

(5) After passing the examination, a Master of Science (M.Sc.) degree will be awarded. Students who have passed the examinations receive a report and a certificate (Appendices 3 and 4) and a diploma supplement (in English and German versions). A further diploma supplement with information on individual modules and their parts (transcript) will also be issued. English versions of the report and certificate will also be issued on application.

(6) Students of the Master's double degree programme in accordance with Section 8 who have passed the examinations receive

1. a report and a certificate from the partner university École Polytechnique;
2. a report and a certificate from Freie Universität Berlin (Appendices 5 and 6) and
3. a joint diploma supplement in English, German and French. For the rest, paragraph 5 applies.

Section 14
Coming into effect and interim regulations

(1) These regulations come into effect on the day after their publication in the FU Mitteilung [Gazette of Freie Universität Berlin].

(2) Simultaneously, the Study Regulations for the Master's degree programme dated 30 January 2013 (FU Mitteilungen [Gazette of Freie Universität Berlin] No. 39/2013, p. 677), and the Examination Regulations for the Master's degree programme dated 30 January 2013 (FU Mitteilungen [Gazette of Freie Universität Berlin] No. 39/2013, p. 715) expire

(3) These Regulations apply to students who enrol for the Master's degree programme at Freie Universität Berlin after these Regulations come into effect as well as to students who enrolled on the Master's degree programme at Freie Universität Berlin before these Regulations came into effect.

Appendix 1: Module descriptions

Explanations:

Unless reference is made to other Regulations, the following module descriptions specify the following for every module in the Master's degree programme:

- the module name,
- the individuals responsible for the module,
- the admission requirements for the respective module,
- the module content and qualification aims,
- the teaching and learning units for the module,
- the students' study time estimated as necessary to complete the module successfully,
- forms of active participation,
- the examination forms,
- regular attendance obligation,
- the credit points allocated to each module,
- the usual duration of the module,
- how often the module is offered,
- the applicability of the module.

Statements on students' study time required take into account the following in particular:

- active participation in the compulsory attendance phase,
- students' study time required to complete small tasks in the compulsory attendance phase,
- time for independent preparation and follow-up,
- working on study units in online study phases,
- the direct preparation time for examinations,
- the examinations themselves.

The notional times given for independent study (including preparation, follow-up and preparation for examinations) are intended as guidance to help the students in managing the time required for the module. The statements on study hours correspond to the number of credit points allocated to the module as a unit of measurement for the student's approximate study hours required to complete the module successfully. One credit point is equivalent to approximately 30 hours.

Where obligatory regular attendance at the teaching and learning units is stipulated in the following, it is a requirement for the attainment of the credit points for each module alongside active participation in the learning and teaching units and successful completion of the examination. Regular attendance entails at least 85% attendance at the learning and teaching units in the module for which attendance is obligatory. If regular attendance at a module's learning and teaching units is not obligatory, it is nevertheless strongly recommended. Lecturers may not specify obligatory attendance for learning and teaching units if participation in these is merely recommended in the following.

The module examination must be taken for each module where an examination is scheduled. Graded modules can only be passed by way of an examination (module examination). The module examination must be related to the module's qualification aims and tests a sample of these aims. The examination scope is limited to the amount necessary to do this. In modules where alternative forms of examination are scheduled, the lecturer responsible for the module must specify the examination form for each semester in the first lecture at the latest.

Active participation and regular attendance at the teaching and learning units and successful completion of the examinations in a module are all prerequisites for gaining the credit points allocated to each module.

1. Compulsory area

Module: Advanced Laboratory Course for Master Students	
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics	
Responsible for the module: Module lecturers	
Admission requirements: none	
Qualification aims: The students have mastered more complex issues in physics. They are familiar with and can apply the more advanced experimental methods used in current physics research to solve these issues. They are able to master a new field of work in a short time from current specialist literature and to communicate it comprehensibly in presentations.	
Content: Study of literature as introduction to a new field; close study of physics issues, modern experimental methods and measurement technologies; documentation of experimental process; critical evaluation and discussion of findings; written presentation of issues, evaluation and findings; presentation and explanation of experimental methods, their possibilities and limitations. Topic fields: solid state physics (magnetism, surface physics, superconductivity), atomic and molecular physics, nuclear physics, biophysics.	

Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Practical	6	Carrying out and documenting practical experiments	Attendance at practical (P) Practical (P) preparation and follow-up	90 150
Seminar	2	Lecture of approx. 20 minutes, participation in discussion	Attendance at seminar (S) Seminar (S) preparation and follow-up	30 30

Module examination	none	
Module language	English (or German)	
Compulsory regular attendance	Yes	
Study time, total hours	300 hours	10 CP
Duration of module	One semester	
Module offered	Every semester	
Application	Master's degree programme in Physics	

Module: Selected Topics in Physics	
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics	
Responsible for the module: Module lecturers	
Admission requirements: none	
Qualification aims: The students have a deeper knowledge of a topic in physics and are able to prepare it for a scientific presentation and convey their knowledge to others through a scientific lecture and chairing a scientific discussion. They are able to adapt a scientific presentation to suit the audience's level of knowledge. They are able to reflect on the literature and to answer critical questions in detail on the basis of their reading.	
Content: Guided by their lecturers, the students work on, present and discuss topics from a variety of fields relating to current issues and methods of modern physics on the basis of specialist literature.	

Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Seminar	2	Lecture (approx. 30 minutes), participation in discussion	Attendance at seminar (S) Seminar (S) preparation and follow-up	30 120

Module examination	none	
Module language	English (or German)	
Compulsory regular attendance	Yes	
Study time, total hours	150 hours	5 CP
Duration of module	One semester	
Module offered	Every semester	
Application	Master's degree programme in Physics	

2. Compulsory elective area

2.1. Modules from the field of Theoretical Physics

Module: Advanced Quantum Mechanics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The students deepen their knowledge of quantum mechanics. They understand the concepts and methods of advanced quantum mechanics and can describe these verbally and in mathematical terms and apply them confidently to fundamental issues in physics.				
Content: Advanced concepts of quantum mechanics are explored in depth in the module. The content includes a selection from the following topics: many-particle systems, second quantisation formalism, approximation methods, Bose and Fermi statistics, field quantisation, correlation functions, relativistic quantum theory and Dirac equations, scattering theory, current issues and methods of quantum theory (e.g. path integral formulation, quantum information).				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Compulsory elective lecture	4	–	Attendance at compulsory elective lecture (CEL) Compulsory elective lecture (CEL) preparation and follow-up	60 60
Practice	2	Successful work on practice tasks	Attendance at practice seminar (PS) Work on practice tasks Preparation for examination and examination	30 90 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		300 hours		10 CP
Duration of module		One semester		
Module offered		At least every second semester		
Application		Master's degree programme in Physics		

Module: Statistical Physics and Thermodynamics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The students are able to name and describe the principle concepts and theorems of statistical physics and thermodynamics. They are also capable of applying the methods they have learnt to existing problems and to solve them. The students have also mastered the calculation methods necessary for dealing with statistical physics and thermodynamics and are able to apply them.				
Content: Elementary statistics and the laws of large numbers, equilibrium ensembles, the principle of maximum entropy, main theorems of thermodynamics, thermodynamic potentials, thermodynamic processes, phase transition, ideal quantum gases, interactive systems				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Compulsory elective lecture	4	–	Attendance at compulsory elective lecture (CEL) Compulsory elective lecture (CEL) preparation and follow-up	60 60
Practice	2	Successful work on practice tasks	Attendance at practice seminar (PS) Work on practice tasks	30 90

			Preparation for examination and examination	60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		300 hours		10 CP
Duration of module		One semester		
Module offered		At least every second semester		
Application		Master's degree programme in Physics		

Module: Advanced Statistical Physics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The students have further deepened their knowledge of the fundamental concepts and theorems of statistical physics. They can name, describe and apply them and apply the methods they have learnt to existing problems to solve them. The students have extended their knowledge of methods and calculation methods in the field of statistical physics and are now able to apply these to more complex issues. Using the methods they have learnt, they are also able to derive and analyse microscopic physical processes / laws at the macroscopic level.				
Content: A selection of the following advanced topics of statistical physics: non-equilibrium thermodynamics (entropy production, Onsager relations), linear response theory and fluctuation-dissipation theorem, stochastic processes (Markov processes, master equation, Langevin equation and Fokker-Planck equation), kinetic theory, phase transition (Landau theory, Gauss fluctuations, correlation functions, renorming groups), theory of liquids, hydrodynamics and elasticity, statistical quantum mechanics, exactly solvable models.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Compulsory elective lecture	4	–	Attendance at compulsory elective lecture (CEL) Compulsory elective lecture (CEL) preparation and follow-up	60 60
Practice	2	Successful work on practice tasks	Attendance at practice seminar (PS) Work on practice tasks Preparation for examination and examination	30 90 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		300 hours		10 CP
Duration of module		One semester		
Module offered		At least every second semester		
Application		Master's degree programme in Physics		

Module: Quantum Field Theory and Many-Body Physics			
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics			
Responsible for the module: Module lecturers			
Admission requirements: none			
Qualification aims: Students understand the concepts and methods of quantum field theory with the focus on many-body physics. They can reproduce these verbally, present them mathematically and apply them to issues of many-body physics.			
Content: Green's functions, diagrammatic perturbation theory and Feynam diagrams, non-perturbative methods, selected applications in condensed matter or relativistic field theory			
Teaching and learning units	**Compulsory attendance** (Semester hours	**Forms of active participation**	**Study time** (hours)

	per week = SH)			
Compulsory elective lecture	4	–	Attendance at compulsory elective lecture (CEL) Compulsory elective lecture (CEL) preparation and follow-up	60 60
Practice	2	Successful work on practice tasks	Attendance at practice seminar (PS) Work on practice tasks Preparation for examination and examination	30 90 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		300 hours		10 CP
Duration of module		One semester		
Module offered		At least every second semester		
Application		Master's degree programme in Physics		

2.2. Modules from the field of Experimental Physics

Module: Advanced Solid State Physics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: Students have a detailed, critical understanding of some areas of solid state physics and of the most up-to-date commonly used experimental methods. Students can apply their knowledge to concrete issues.				
Content: This module deepens the students' knowledge of fundamental concepts of solid state physics (describing the geometrical structure, electronic and vibronic conditions, elementary excitations, collective phenomena) on the basis of one or more relevant areas of solid state physics (semiconductor physics, physics of boundary layers and nanostructures, photonics, superconductivity, magnetism, ferroelectricity).				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Compulsory elective lecture	4	–	Attendance at compulsory elective lecture (CEL) Compulsory elective lecture (CEL) preparation and follow-up	60 60
Practice	2	Successful work on practice tasks	Attendance at practice seminar (PS) Work on practice tasks Preparation for examination and examination	30 90 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		300 hours		10 CP
Duration of module		One semester		
Module offered		At least every second semester		
Application		Master's degree programme in Physics		

Module: Advanced Atomic and Molecular Physics	
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics	
Responsible for the module: Module lecturers	

Admission requirements: none				
Qualification aims: Students have a detailed and critical understanding of some areas of atomic and molecular physics and of modern spectroscopic methods. They can apply their knowledge to concrete issues.				
Content: The module covers in more depth the fundamental concepts of atomic and molecular physics (quantum mechanical description of atoms and molecules, the interaction of atoms and molecules with electromagnetic fields) on the basis of one or more relevant areas of atomic and molecular physics (e.g. single atoms and molecules in traps, spectroscopy of atomic clusters, biomolecules, single molecule experiments in the condensed phase).				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Compulsory elective lecture	4	–	Attendance at compulsory elective lecture (CEL) Compulsory elective lecture (CEL) preparation and follow-up	60 60
Practice	2	Successful work on practice tasks	Attendance at practice seminar (PS) Work on practice tasks Preparation for examination and examination	30 90 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		300 hours		10 CP
Duration of module		One semester		
Module offered		At least every second semester		
Application		Master's degree programme in Physics		

Module: Advanced Biophysics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: Students have a detailed and critical understanding of some areas of molecular biophysics and of modern spectroscopic methods. They can apply their knowledge to concrete issues.				
Content: In this module, a range of biophysical concepts and methods are introduced or covered in more depth. The module focuses particularly on the application of selected methods of spectroscopy and diffraction to biologically relevant systems such as proteins, nucleic acid and membranes. The experimental approaches discussed include a selection of the methods listed below: absorption spectroscopy in the visible range, UV and IR, fluorescence spectroscopy, time-resolved emission and absorption spectroscopy, spectroscopy with linearly and circularly polarised light, vibrational spectroscopy: Fourier transform infrared spectroscopy, resonance Raman spectroscopy; x-ray and neutron diffraction, magnetic resonance and x-ray spectroscopy, dynamic light scattering, single molecule spectroscopy, optical tweezers.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Compulsory elective lecture	4	–	Attendance at compulsory elective lecture (CEL) Compulsory elective lecture (CEL) preparation and follow-up	60 90
Practical	4	Carrying out and documenting practical experiments	Attendance at practical (P) Preparation and follow-up of experiments Preparation for examination and examination	60 30 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes)		
Module language		English (or German)		
Compulsory regular attendance		Practicals: Yes; Lectures: Attendance recommended		

Study time, total hours	300 hours	10 CP
Duration of module	One semester	
Module offered	At least every second semester	
Application	Master's degree programme in Physics	

3. Elective area

(* At least seven elective modules will be offered in each academic year.)

Module: Theoretical Solid State Physics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: Students understand the concepts and methods of theoretical solid state physics. They can present these verbally and mathematically and apply them to current issues of solid state physics.				
Content: Phonons, electrons, Fermi liquid theory, electron-phonon interaction, magnetism, transport theory, disordered systems, fundamental concepts for the description of solids and their excitations, applications (e.g. superconductivity, magnetism), quantum field theory methods for the description of solids, (perturbation theory, molecular field approximation, functional integrals), linear answer and transport properties, highly correlated systems, current topics				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	4	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	60 60
Practice	2	Successful work on practice tasks	Attendance at practice seminar (PS) Work on practice tasks Preparation for examination and examination	30 90 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		300 hours		10 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Advanced Theoretical Biophysics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The module enables the students to select the field they wish to concentrate on. They have an overview of theoretical methods which are currently applied in biophysical research, are able to apply them and can critically assess the advantages and disadvantages of various methods for biologically relevant issues.				
Content: The module covers a selection of the following topics: calculation of the conformational potentials of biomolecules; classical, quantum-mechanical and combined classical-quantum mechanical molecular modelling methods; modelling biochemical reactions, electrostatic models of biomolecules; basic methods in bioinformatics.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up Attendance at practical (P)	30 45 30

Practical (Laboratory)	2	Successful work on numeric modelling and practical tasks, documentation of findings	Preparation and follow-up of experiments Preparation for examination and examination	75 60
Module examination		Written report (approx. 30 pages) or written examination (90 minutes) or oral examination (approx. 30 minutes)		
Module language		English (or German)		
Compulsory regular attendance		Practicals: Yes; Lectures: Attendance recommended		
Study time, total hours		240 hours		8 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Nanophysics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: Students are familiar with the current state of research and the future challenges in the modern, interdisciplinary research field of nanophysics. They are able to interpret and evaluate experimental and theoretical findings.				
Content: The module uses examples to introduce the principles of nanophysical systems, important investigation methods and possible applications. The teaching unit may be oriented on particular nanosystems, groups of physics topics or investigation methods. Alongside textbooks, original literature is also used to discuss the current state of research.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		150 hours		5 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Ultrafast Spectroscopy and Nonlinear Optics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The students gain fundamental knowledge in the field of nonlinear optics and the dynamics of elementary optically induced processes. They have an overview of modern methods of ultrafast spectroscopy and nonlinear optics and how to apply them to particular problems.				
Content: Principles of the interaction of light and matter, wave packet dynamics, electron dynamics and elementary scattering processes, collective excitations in solids. Experimental methods of ultrafast spectroscopy and selected applications, e.g. femtochemistry, coherent control, photoelectron spectroscopy, attosecond physics, diffraction methods, structural dynamics.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	

Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		150 hours		5 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Spectroscopy with Synchrotron Radiation				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The module enables the students to select the field they wish to concentrate on. They have an overview of the spectroscopic methods which are applied in current experimental research with synchrotron radiation and are able to independently assess their advantages and disadvantages for a particular issue.				
Content: The module covers a selection of the following topics: X-ray sources and emissions of intensive X-rays, physical principles of nanometer optics, nanometer technologies, modern spectroscopic methods with micro/nano structural resolution such as µEXAFS/µXANES, µXRF, µXBIC, space and time-resolved spectroscopic methods.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practical	2	Carrying out and documenting practical experiments	Attendance at practical (P) Preparation and follow-up of experiments Preparation for examination and examination	30 75 60
Module examination		Written report (approx. 30 pages) or written examination (90 minutes) or oral examination (approx. 30 minutes)		
Module language		English (or German)		
Compulsory regular attendance		Practicals: Yes; Lectures: Attendance recommended		
Study time, total hours		240 hours		8 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Photobiophysics and Photosynthesis
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics
Responsible for the module: Module lecturers
Admission requirements: none
Qualification aims: On the basis of selected examples, students are familiar with current issues of biophysics research in the field of photobiophysics and photosynthesis. They know the new methods and the possibilities they offer and are able to interpret and critically evaluate findings in relation to the current state of knowledge.
Content: The conversion and utilisation of light in biological systems is of fundamental importance for life on earth. Topics are: overview of photosynthesis and photosynthetic organisms; photophysical principles of light absorption, fluorescence

emission and energy transfer in photosynthetic antenna systems, light-driven processes in co-factor protein complexes, selected methods of photobiophysics, photosensors, signal transduction, proton and electron transfer in biological systems, time-resolved spectroscopy.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 30
Practice	1	Laboratory experiments, documentation and parallel discussions	Attendance at practice seminar (PS) Practice seminar (PS) preparation and follow-up Preparation for examination and examination	15 15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		150 hours		5 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Semiconductor Physics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The students have a detailed, critical understanding of some areas of semiconductor physics and aspects of their application. They are able to apply their knowledge to concrete issues.				
Content: The module covers in depth the fundamental concepts of electronic conditions in semiconductors and their realisation with inorganic or organic materials, of charge carriers transport in semiconductors and contact systems and of the influence of structural dimensions on the properties of semiconductors. Special aspects in the application of semiconductors and selected characterisation methods of semiconductors and semiconductor boundary layer properties are examined.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		150 hours		5 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: General Relativity	

University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: Students understand the concepts and methods of the general theory of relativity and can apply them. They are able to describe the mathematical prerequisites and physical assumptions for the general theory of relativity and to present fundamental conclusions.				
Content: Riemannian geometry, the equivalence principle, Einstein equations, applications of the general theory of relativity, (Schwarzschild solution, gravitational collapse and black holes, gravitational waves), cosmology				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		150 hours		5 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: History of Physics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The students gain a historical understanding of the basic terms of physics and its methods of operation. This understanding is intended to contribute in particular to maintaining the awareness of the mutability of these basic terms and to get to know innovative research perspectives on the basis of historical examples. In addition, students gain an overview of the development of physics from its beginnings up to the present; the overview is deepened on the technological level by particular examples. The module also aims to give students an understanding of how research in physics is embedded in its particular cultural and social structures. The most important aims include a thoughtful use of terms and methods, an eye for development potential and a keen sense of the links between physical knowledge and its context.				
Content: - knowledge of physics in classical times: Aristoteles and Archimedes - the development of physics in non-European cultures: the Chinese example - the heritage of classical physics in the Arabic and Latin Middle Ages - the scientific revolution of the early modern period - the analytical tradition of the 18th and 19th centuries - the consolidation of classical physics - reflection on the culture of the discipline in relation to gender aspects - the 20th century revolution in physics				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60

Module examination	Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)	
Module language	English (or German)	
Compulsory regular attendance	Attendance recommended	
Study time, total hours	150 hours	5 CP
Duration of module	One semester	
Module offered	Not regularly*	
Application	Master's degree programme in Physics	

Module: Advanced Topics in Theoretical Condensed Matter Physics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The module enables the students to select the field they wish to concentrate on. They learn theoretical approaches and concepts which are used in current condensed matter theory and are able to master them and apply them.				
Content: The module covers a selection of the following current topics in condensed matter theory: phase transitions, low-dimensional and mesoscopic systems, correlated electron systems, condensed matter in nonequilibrium.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		150 hours		5 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Special Topics in Magnetism				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: Students are familiar with current research issues in the field of magnetism and currently used methods and their possibilities. They are able to interpret and critically evaluate findings in relation to the current state of knowledge.				
Content: On the basis of selected examples, the module identifies the principles and applications, the current state of research and the possibilities and limitations of modern experimental methods in the field of research into magnetism. Topics covered may include: magnetic nanostructures, new magnetic materials, magneto-transport phenomena / spin electronics, magnetisation dynamics, magnetic interface phenomena / magnetic interfaces, micromagnetism / magnetic domains, molecular magnetism.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45

Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		150 hours		5 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Special Topics in Molecular Physics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: Students are familiar with current issues in molecular physics and in particular the application of modern spectroscopy technologies to the examination of issues in molecular physics. They are able to interpret and critically evaluate findings in relation to the current state of knowledge.				
Content: The module gives a more thorough introduction to selected modern concepts in molecular physics, using examples. Specific topics may include single molecule technologies, electron and nuclear magnetic resonance spectroscopy, oscillation spectroscopy and ultrafast spectroscopy.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		150 hours		5 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Special Topics in Molecular Biophysics
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics
Responsible for the module: Module lecturers
Admission requirements: none
Qualification aims: Students are familiar with current research issues in the field of molecular biophysics and with new methods and the possibilities they offer and are able to interpret and critically evaluate findings in relation to the current state of knowledge.
Content: On the basis of selected examples, the module identifies the principles and applications, the current state of research and the possibilities and limitations of modern concepts and methods in the field of molecular biophysics. Topics covered are oriented on the main current research issues in biophysics in the faculty and may include: advanced approaches in vibrational, x-ray or electron spin resonance spectroscopy into biomolecules; biomolecules on surfaces or in membranes; tracing the function of photoreceptors or biocatalysts at atomic level.

Teaching and learning units	Compulsory attendance (Semester hours per week = SH)	Forms of active participation	Study time (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		150 hours		5 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Advanced Astronomy and Astrophysics				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The module conveys deeper knowledge in modern areas of astronomy and astrophysics through alternating wide-ranging lectures. In the laboratory work, students acquire practical skills relating to astronomic observation methods and learn numerical methods applicable to astrophysical issues.				
Content: - alternating lectures on various special topics in astronomy and astrophysics (e.g. relativistic astrophysics, cosmology, physics of stellar atmospheres, cosmic electrodynamics, ISM, astronomical observation methods, planetary physics, stellar structure and stellar development) - practical exercises in astronomy (e.g. astrometry, stellar spectroscopy, determining distances, galactic rotation, observations with the centre's own telescopes) - numerical methods for astrophysical issues				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lecture 1	2	–	Attendance at lecture 1 (L1) Lecture 1 (L1) preparation and follow-up	30 45
Lecture 2	2	–	Attendance at lecture 2 (L2) Lecture 2 (L2) preparation and follow-up	30 45
Laboratory practical	4	Practical experiments with written documentation	Attendance at practical (P) Practical (P) preparation and follow-up Preparation for examination and examination	60 120 30
Module examination		Oral examination (approx. 30 minutes)		
Module language		English (or German)		
Compulsory regular attendance		Practicals: Yes; Lectures: Attendance recommended		
Study time, total hours		360 hours		12 CP
Duration of module		One or two semesters		
Module offered		At least every second semester		
Application		Master's degree programme in Physics		

Module: Modern Methods in Theoretical Physics A				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The module enables the students to select the field they wish to concentrate on. Students master selected methods applied in current theoretical research and are able to apply them independently.				
Content: The module covers a selection of the following topics: group theory and symmetries in physics, density functional theory, path integral formulation, density matrix theory, quantum optics, field theory, equilibrium and nonequilibrium theory.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		150 hours		5 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Modern Methods in Theoretical Physics B				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The module enables the students to select the field they wish to concentrate on. Students master selected methods applied in current theoretical research and are able to analyse concrete issues independently and to solve them using the methods they have learnt.				
Content: The module covers a selection of the following topics: group theory and symmetries in physics, density functional theory, path integral formulation, density matrix theory, quantum optics, field theory, equilibrium and nonequilibrium theory.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	2	Successful work on practice tasks	Attendance at practice seminar (PS) Work on practice tasks Preparation for examination and examination	30 75 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		240 hours		8 CP
Duration of module		One semester		
Module offered		Not regularly*		

Application	Master's degree programme in Physics

Module: Modern Methods in Theoretical Physics C				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The module enables the students to select the field they wish to concentrate on. Students master a wide range of methods applied in current theoretical research and are able to analyse concrete issues, to select appropriate methods to solve them and to apply these methods successfully.				
Content: The module covers a selection of the following topics: group theory and symmetries in physics, density functional theory, path integral formulation, density matrix theory, quantum optics, field theory, equilibrium and nonequilibrium theory.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	4	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	60 60
Practice	2	Successful work on practice tasks	Attendance at practice seminar (PS) Work on practice tasks Preparation for examination and examination	30 90 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		300 hours		10 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

Module: Modern Methods in Experimental Physics A				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: none				
Qualification aims: The module enables the students to select the field they wish to concentrate on. Students gain an overview of selected methods currently applied in experimental research and are able to independently evaluate their advantages and disadvantages for a particular issue.				
Content: The module covers a selection of the following topics: spectroscopic methods (optical spectroscopy, electron spectroscopy, x-ray spectroscopy, magnetic resonance spectroscopy), diffraction methods, imaging methods, correlation measurements, time-resolved methods, transport measurements.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up	30 45
Practice	1	Participation in discussion	Attendance at practice seminar (PS) Preparation for examination and examination	15 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		

Study time, total hours	150 hours	5 CP
Duration of module	One semester	
Module offered	Not regularly*	
Application	Master's degree programme in Physics	

Module: Modern Methods in Experimental Physics B	
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics	
Responsible for the module: Module lecturers	
Admission requirements: none	
Qualification aims: The module enables the students to select the field they wish to concentrate on. Students gain an overview of the methods currently applied in experimental research and are able to independently evaluate their advantages and disadvantages for a particular issue. They are able to analyse concrete issues independently and interpret measurement results.	
Content: The module covers a selection of the following topics: spectroscopic methods (optical spectroscopy, electron spectroscopy, x-ray spectroscopy, magnetic resonance spectroscopy), diffraction methods, imaging methods, correlation measurements, time-resolved methods, transport measurements.	

Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	2	–	Attendance at lecture (L) Lecture (L) preparation and follow-up Attendance at practice seminar (PS)	30 45 30
Practice	2	Successful work on practice tasks	Work on practice tasks Preparation for examination and examination	75 60

Module examination	Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)	
Module language	English (or German)	
Compulsory regular attendance	Attendance recommended	
Study time, total hours	240 hours	8 CP
Duration of module	One semester	
Module offered	Not regularly*	
Application	Master's degree programme in Physics	

Module: Modern Methods in Experimental Physics C	
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics	
Responsible for the module: Module lecturers	
Admission requirements: none	
Qualification aims: The module enables the students to select the field they wish to concentrate on. Students gain an overview of a range of the methods currently applied in experimental research and are able to independently evaluate their advantages and disadvantages for a particular issue. They are able to analyse concrete issues independently and interpret measurement results.	
Content: The module covers a selection of the following topics: spectroscopic methods (optical spectroscopy, electron spectroscopy, x-ray spectroscopy, magnetic resonance spectroscopy), diffraction methods, imaging methods, correlation measurements, time-resolved methods, transport measurements.	

Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Lectures	4	–	Attendance at lecture (L) Lecture (L) preparation and follow-up Attendance at practice seminar	60 60 30

Practice	2	Successful work on practice tasks	(PS) Work on practice tasks Preparation for examination and examination	 90 60
Module examination		Written examination (90 minutes) or oral examination (approx. 30 minutes) or term paper (approx. 15 pages)		
Module language		English (or German)		
Compulsory regular attendance		Attendance recommended		
Study time, total hours		300 hours		10 CP
Duration of module		One semester		
Module offered		Not regularly*		
Application		Master's degree programme in Physics		

4. Research phase

Module: Scientific Specialisation				
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics				
Responsible for the module: Module lecturers				
Admission requirements: Successful completion of the module “Advanced Laboratory Course for Master Students” (10 CP) and one module in theoretical physics from the compulsory elective area comprising 10 CP and additional Master’s degree programme modules comprising at least 25 CP				
Qualification aims: Independent orientation in the scientific research field of the Master’s thesis. Students are familiar with the current state of scientific knowledge in this field and are able to assess the advantages and disadvantages of various approaches to a particular current issue and to argue for these in discussion, giving reasons. They have the special knowledge of the discipline necessary to complete their Master’s thesis.				
Content: In this module, the students familiarise themselves in detail with a modern field of research prescribed by their research phase supervisor on the basis of original literature (scientific journals and monographs). The focus is on the scientific content, the critical evaluation of literature, scientifically correct presentation and the rules of good scientific practice. On the basis of the literature studies, open issues are defined and the investigations necessary to answer them are discussed and planned. The skills of expert presentation and critical discussion are practised in seminars.				
Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Project work	4	Documentation and evaluation of original literature, calculations	Attendance at project work (PW) mentoring Project work (PW) preparation and follow-up	60 180
Seminar	2	Participation in discussion	Attendance at seminar (S) Seminar (S) preparation and follow-up Preparation for examination and examination	30 30 150
Module examination		Scientific lecture (approx. 30 minutes) with subsequent discussion (approx. 30 minutes)		
Module language		English (or German)		
Compulsory regular attendance		Yes		
Study time, total hours		450 hours		15 CP
Duration of module		One semester		
Module offered		Every semester		
Application		Master's degree programme in Physics		

Module: Methodology and Project Planning	
University/Department/Teaching Unit: Freie Universität Berlin/Physics/Physics	
Responsible for the module: Module lecturers	
Admission requirements: Successful completion of the module “Advanced Laboratory Course for Master Students” (10 CP) and one module in theoretical physics from the compulsory elective area comprising 10 CP and additional Master’s degree programme modules comprising at least 25 CP	

Qualification aims: Students are familiar with the particular physics-specific methods and skills necessary to complete their Master's thesis and can apply them in practice. They are able to plan a research project, to present the planning in written form giving reasons and to defend it in the face of critical questions.

Content: In this module, students learn selected theoretical and/or experimental methods and skills necessary to complete their Master's thesis under expert guidance. Depending on whether the work is experimental or theoretical in orientation, the focus is on the confident and precise use of measurement apparatus, algorithms, programs and aids and the reliable application of the necessary skills. Building on the mastery of these methods, the planning of a sample scientific project is drawn up and presented in written form.

Teaching and learning units	**Compulsory attendance** (Semester hours per week = SH)	**Forms of active participation**	**Study time** (hours)	
Project work	4	Presentation of planned project, participation in discussion	Attendance at project work (PW) mentoring Project work (PW) preparation and follow-up	60 180
Practical (experimental or theoretical)	7	Carrying out experiments, written documentation approx. 20 pages	Attendance at practical (P) Practical (P) preparation and follow-up	105 105

Module examination	none	
Module language	English (or German)	
Compulsory regular attendance	Yes	
Study time, total hours	450 hours	15 CP
Duration of module	One semester	
Module offered	Every semester	
Application	Master's degree programme in Physics	

Appendix 2: Sample programme plans

2.1. Sample programme plan for the Master's degree programme in Physics

The modules of the first and second semesters may be taken in any order. Students are recommended to divide the work load evenly between the two semesters.

<table>
<tr><th>1st semester
30 CP</th><th>2nd semester
30 CP</th><th>3rd semester
30 CP</th><th>4th semester
30 CP</th></tr>
<tr><td colspan="2">Advanced phase</td><td colspan="2">Research phase</td></tr>
<tr><td>Compulsory module
Advanced Laboratory Course
for Master Students
(10 CP)</td><td>Compulsory module
Selected Topics in Physics
(5 CP)</td><td>Compulsory module
Scientific Specialisation
(15 CP)</td><td rowspan="3">Master's thesis
with accompanying seminar
(30 CP)</td></tr>
<tr><td colspan="2">Compulsory elective area 20 CP
(at least one module from Theoretical Physics 10 CP)</td><td rowspan="2">Compulsory module
Methodology and Project Planning
(15 CP)</td></tr>
<tr><td>Elective area
10 CP</td><td>Elective area
15 CP</td></tr>
</table>

2.2. Sample programme plan for the Master's double degree programme in Physics

<table>
<tr><th>1. semester
30 CP</th><th>2. semester
30 CP</th><th>3. semester
30 CP</th><th>4. semester
30 CP</th></tr>
<tr><td colspan="2">Advanced phase</td><td colspan="2">Research phase
École Polytechnique de Paris</td></tr>
<tr><td>Compulsory module
Advanced Laboratory Course
for Master Students
(10 CP)</td><td>Compulsory module
Selected Topics in Physics
(5 CP)</td><td rowspan="3">e.g.
M2 programme "Nanoscience"
30 CP</td><td rowspan="3">Master's thesis
and accompanying seminar
(30 CP)</td></tr>
<tr><td>Compulsory module
Statistical Physics and Thermodynamics
(10 CP)</td><td>Compulsory elective area 10 CP</td></tr>
<tr><td>Elective area
10 CP</td><td>Elective area
15 CP</td></tr>
</table>

Appendix 3: Report (sample)

Freie Universität Berlin
Department of Physics

Report

[First name/surname]

Date of birth [day/month/year] in [place of birth]

has successfully completed the Master's degree programme in

Physics

on the basis of the Examination Regulations dated 12 February 2020 (FU Mitteilungen [Gazette of Freie Universität Berlin] No. [XX]/year) and has achieved the overall grade

[grade stated as a number and

text].

The examinations were scored as follows:

Subject areas	Credit points	Grade
Advanced phase modules	60 (45)	
Research phase modules	30 (15)	
Master's thesis	30 (30)	

The Master's thesis was written on the following topic: [XX]

Berlin, [day/month/year] (Official seal)

Dean

Chair
of the Examining Board

Grading scale: 1.0 – 1.5 very good; 1.6 – 2.5 good; 2.6 – 3.5 satisfactory; 3.6 – 4.0 sufficient; 4.1-5.0 deficient
Undifferentiated assessments: PA – pass; FA – fail
The credit points are in line with the European Credit Transfer and Accumulation System (ECTS)
A portion of the attainments is ungraded; the number of credit points in brackets specifies the extent of attainments assessed in a differentiated manner by way of a grade that impact the overall grade.

Appendix 4: Certificate (sample)

Freie Universität Berlin
Department of Physics

C e r t i f i c a t e

[First name/surname]

Date of birth [day/month/year] in [place of birth]

has successfully completed the Master's degree programme in

Physics

text].

In accordance with the Examination Regulations dated 12 February 2020 (FU Mitteilungen [Gazette of Freie Universität Berlin] No. [XX]/year),

the following

Master of Science (M.Sc.)

degree is hereby awarded.

Berlin, [day/month/year] (Official seal)

Dean

Chair
of the Examining Board

Appendix 5: Report
(sample for Master's double degree programme)

Freie Universität Berlin
Department of Physics

Report

[First name/surname]

Date of birth [day/month/year] in [place of birth]

has successfully completed the Master's degree programme, as part of the German-French Master's double degree programme with École Polytechnique de Paris, in

Physics

on the basis of the Examination Regulations dated 12 February 2020 (FU Mitteilungen [Gazette of Freie Universität Berlin] No. [XX]/year) and has achieved the overall grade

[grade stated as a number and

text].

The examinations were scored as follows:

Subject areas	Credit points	Grade
Advanced phase modules	60 (45)	
Research phase modules at École Polytechnique	30 (30)	
Master's thesis	30 (30)	

The Master's thesis was written on the following topic: [XX]

Berlin, [day/month/year] (Official seal)

Dean

Chair
of the Examining Board

Grading scale: 1.0 – 1.5 very good; 1.6 – 2.5 good; 2.6 – 3.5 satisfactory; 3.6 – 4.0 sufficient; 4.1-5.0 deficient
Undifferentiated assessments: PA – pass; FA – fail
The credit points are in line with the European Credit Transfer and Accumulation System (ECTS)
A portion of the attainments is ungraded; the number of credit points in brackets specifies the extent of attainments assessed in a differentiated manner by way of a grade that impact the overall grade.

Appendix 6: Certificate
(sample for Master's double degree programme)

Freie Universität Berlin
Department of Physics

Certificate

[First name/surname]

Date of birth [day/month/year] in [place of birth]

has successfully completed the Master's degree programme, as part of the German-French Master's double degree programme
with École Polytechnique de Paris
, in

Physics

.

In accordance with the Examination Regulations dated 12 February 2020 (FU Mitteilungen [Gazette of Freie Universität Berlin] No. [XX]/year),

the following

Master of Science (M.Sc.)

degree is hereby awarded.

Berlin, [day/month/year] (Official seal)

Dean

Chair
of the Examining Board