UNIVERSITÄT BAYREUTH

Faculty of Mathematics, Physics & Computer Science

Module Handbook for the Master's Programme Physics

(Version of 1 November 2020)

This English translation is for information purposes only.

The German version is legally binding.

Contents

Note to persons responsible for modules:

The modules are generally not definitively assigned to individual professors. The eligible courses are given by a rotation of different lecturers.

Module name	**Advanced Experimental Physics**
Module label	FEP
Module responsible person of contact	Physics lecturers Lecturers of each course as listed in the course catalogue
Learning objectives	This module teaches competencies related to the practice of advanced methods of experimental physics. This includes the acquisition of advanced skills in fundamental areas of experimental physics.
Content	This module develops and expands both the methodological principles and knowledge of experimental physics acquired during the bachelor's programme. The course offered provide an understanding of advanced methods of experimental physics and the physical questions that these methods may be used to investigate. Particular emphasis is placed on experiments and experimental techniques that provide a foundation for research in physics or related natural sciences, or that contribute to an understanding of modern technical developments in engineering. See the current list of the eligible course (marked with FEP) in the Appendix.
Duration	1 semester
Teaching format and scope	Starting in the winter semester 2020/2021, the module consists of a single lecture of the same name amounting to 4 hours/week.
Credit	6
Grading	Written or oral examination.
Student workload	Attendance: 15 hours for each 1 hr of lectures or 1 hr of tutorials. Total attendance for the required 4 hr/week is 60 hours; Preparation and follow-up work: 60 hours; additional exam preparation: 60 hours.
Applicability	This module lays the groundwork for further experimental research both in physics and related research areas in neighbouring scientific fields. It may also be chosen as a secondary course for another programme.
Availability	Yearly in the winter semesters
Language	German or English

Module name	**Advanced Theoretical Physics**
Module label	FTP
Module responsible person of contact	Physics lecturers Lecturers of each course as listed in the course catalogue
Learning objectives	This module teaches competencies related to the practice of advanced methods of theoretical physics. This includes the acquisition of advanced skills in fundamental areas of theoretical physics.
Content	This module develops and expands both the methodological principles and knowledge of theoretical physics acquired during the bachelor's programme. The courses offered provide an understanding of advanced methods of theoretical physics and the physical relationships that they may be used to describe. Particular emphasis is placed on theoretical methods and lines of questioning in physics that provide a foundation for research in physics or related natural sciences, or that contribute to an understanding of modern technical developments in engineering. See the current list of eligible courses (marked with FTP) in the Appendix.
Duration	1 semester
Teaching format and scope	This module consists of one course of 4 hours/week and tutorials amounting to 2 hours/week.
Credit	9
Grading	Written or oral examination. Participation in tutorials may be a prerequisite of acceptance to the examination.
Student workload	Attendance: 60 hours of lectures and 30 hours of tutorials; The total attendance for lectures and tutorials combined is 90 hours; Preparation and follow-up work: 90 hours; additional exam preparation: 90 hours.
Applicability	This module lays the groundwork for further theoretical research both in physics and related research areas in neighbouring scientific fields. It may also be chosen as a secondary course for another programme
Availability	Yearly in the winter and summer semesters
Language	German or English

Module name	**Physics Focus**
Module label	SCP
Module responsible person of contact	Physics lecturers Lecturers of each course as listed in the course catalogue
Learning objectives	This module teaches research-oriented physics knowledge with a focus on one of the profile-building areas of physics at Bayreuth
Content	The courses of this module address topics in physics that are either directly part of one of the profile-building areas of physics at Bayreuth, or that are dedicated to the study of physical questions relevant to research in these areas. This module studies physical questions that are the subject of current research in the field of physics at Bayreuth and presents the experimental techniques and methods of theoretical physics applied in these areas. See the current list of eligible courses (marked with SCP) in the Appendix.
Duration	1 semester
Teaching format and scope	For this module, a selection of courses totalling 8 hours/week should be made in one of the following five formats: 1) 4 hr lectures and 2 hr tutorials 2) 3 hr lectures and 1 hr tutorials 3) 2 hr lectures and 2 hr tutorials 4) 4 hr lectures 5) 1 hr lectures and 1 hr tutorials 6) 2 hr lectures
Credit	12
Grading	Written or oral examination. Participation in tutorials may be a prerequisite of acceptance to the examination.
Student workload	Attendance: 15 hours for each 1 hr of lectures or 1 hr of tutorials. Total attendance for the required 8 hr/week is 120 hours. Preparation and follow-up work: 120 hours; additional exam preparation: 120 hours
Applicability	In the context of the master's programme, this module can form part of one of the possible focus options "Biological Physics", "Solid State Physics", "Nonlinear Physics", and "Soft Matter Physics". The special expertise developed in this module in one of the profile-building areas of physics at Bayreuth constitutes preparation for independent studies in the corresponding areas offered by the PPS and LPS modules as well as for the independent research thesis required by the MA module. It may also be chosen as a secondary course for another programme.
Availability	Yearly in the winter and summer semesters
Language	German or English

Module name	**Physics Specialisation**
Module label	SPP
Module responsible person of contact	Physics lecturers Lecturers of each course as listed in the course catalogue
Learning objectives	This module teaches specialized knowledge in physics relevant to research in one of the profile-building areas of physics at Bayreuth
Content	The courses of this module address specialized topics in physics that are either directly part of one of the profile-building areas of physics at Bayreuth, or that are dedicated to the study of physical questions relevant to research in these areas. This module studies physical questions that are the subject of current research in the field of physics at Bayreuth and presents specialized experimental techniques or specialized methods of theoretical physics in the context of the chosen lecture course. See the current list of eligible courses (marked with SPP) in the Appendix.
Duration	1 semester
Teaching format and scope	For this module, a selection of courses totalling 4 hours/week should be made in one of the following five formats: 1) 3 hr lectures and 1 hr tutorials 2) 2 hr lectures and 2 hr tutorials 3) 2 hr lectures and 2 hr seminars 4) 4 hr lectures 5) 1 hr lectures and 1 hr tutorials 6) 2 hr lectures
Credit	6
Grading	Written or oral examination. Participation in tutorials may be a prerequisite of acceptance to the examination.
Student workload	Attendance: 15 hours for each 1 hr of lectures or 1 hr of tutorials. Total attendance for the required 4 hr/week is 60 hours. Preparation and follow-up work: 60 hours; additional exam preparation: 60 hours.
Applicability	The module allows students to specialize in one of the focus options “Biological Physics”, “Solid State Physics”, “Nonlinear Physics”, and “Soft Matter Physics”. The special expertise developed in this module in one of the profile-building areas of physics at Bayreuth constitutes preparation for independent studies in the corresponding areas offered by the PPS and LPS modules as well as for the independent research thesis required by the MA module. It may also be chosen as a secondary course for another programme.
Availability	Yearly in the winter and summer semesters
Language	German or English

Module name	**Elective A**
Module label	WFA
Module responsible person of contact	Lecturers in physics and other authorized subjects (minors) Lecturers of each course as listed in the course catalogue
Learning objectives	This module teaches specialized research-oriented competencies and knowledge in areas of physics and other authorized subjects.
Content	Research-oriented topics from sub-domains of physics and other authorized subjects (minors). In particular, these topics include specialized experimental techniques, specialized methods of theoretical description, specialized experimental findings relevant to research in specialized areas of physics, the discussion of specialized model systems and the theoretical results known with regard to each of these systems, as well as detailed knowledge of one domain in physics. See the current list of eligible courses (marked with WFA) in the Appendix. Additional courses for this module are eligible upon request but need to be approved by the Examination Board.
Duration	1 semester
Teaching format and scope	For this module, a selection totalling 6 hours/week should be made from courses offered in one of the following seven formats: 1) 4 hr lectures and 2 hr tutorials 2) 4 hr lectures and 2 hr seminars 3) 3 hr lectures and 1 hr tutorials 4) 4 hr lectures 5) 2 hr lectures and 2 hr tutorials 6) 2 hr lectures and 2 hr seminars 7) 1 hr lectures and 1 hr tutorials 8) 2 hr lectures
Credit	9
Grading	Written or oral examination. Participation in tutorials may be a prerequisite of acceptance to the examination.
Student workload	Attendance: 15 hours for each 1 hr of lectures or 1 hr of tutorials or seminars. The total attendance for the required 6 hours/week is 90 hours; Preparation and follow-up work: 90 hours; additional exam preparation: 90 hours.
Applicability	This module allows students to concentrate on a current physically oriented research area in addition to the SCP and SPP modules, or broaden their studies by taking courses in other authorized related subjects.
Availability	Yearly in the winter and summer semesters
Language	German or English

Module name	**Elective B**
Module label	WFB
Module responsible person of contact	Lecturers in physics and other authorized subjects (minors) Lecturers of each course as listed in the course catalogue
Learning objectives	This module teaches a compact selection of research-oriented competencies and knowledge in areas of physics and other authorized subjects.
Content	Research-oriented topics from sub-domains of physics and other authorized subjects (minors). In particular, these topics include specialized experimental techniques, specialized methods of theoretical description, specialized experimental findings relevant to research in specialised areas of physics, the discussion of specialized model systems and the theoretical results known with regard to each of these systems, as well as compact detailed knowledge of one domain in physics. See the current list of eligible courses (marked with WFA) in the Appendix. Additional courses for this module are eligible upon request but need to be approved by the Examination Board.
Duration	1 semester
Teaching format and scope	For this module, a selection totalling 4 hours/week should be made from courses offered in one of the following five formats: 1) 3 hr lectures and 1 hr tutorials 2) 2 hr lectures and 2 hr tutorials 3) 2 hr lectures and 2 hr seminars 4) 4 hr lectures 5) 1 hr lectures and 1 hr tutorials 6) 2 hr lectures
Credit	6
Grading	Written or oral examination. Participation in tutorials may be a prerequisite of acceptance to the examination.
Student workload	Attendance: 15 hours for each 1 hr of lectures or 1 hr of tutorials or seminars. The total attendance for the required 4 hours/week is 60 hours; Preparation and follow-up work: 60 hours; additional exam preparation: 60 hours
Applicability	This module allows students to concentrate on a current physically oriented research area in addition to the SCP and SPP modules, or broaden their studies by taking courses in other authorized related subjects.
Availability	Yearly in the winter and summer semesters
Language	German or English

Module name	**Physics Internship**
Module label	PPD
Module responsible person of contact	Physics lecturers Lecturers of each course as listed in the course catalogue
Learning objectives	Understanding of a specific selection of physical phenomena by experimental investigation and measurement • Ability to utilize modern measurement equipment • Ability to apply modern methods of data assessment
Content	Execution of three to five physics experiments with methods and subject matter relevant to current problems in physics. Each set of testing apparatus includes measurement equipment used in the context of current research. The experiments can be adapted to fit the specialization.
Key transferable skills	Teamwork, use of computers, literature research
Duration	1 semester
Teaching format and scope	Small group advanced physics practical sessions (6 hr/week)
Credit	6
Grading	Written research report
Student workload	Attendance: 90 hours; Preparation and post-practical work, report write-up: 90 hours
Applicability	This module is only applicable in the context of the master's programme.
Availability	Yearly in the summer semester
Language	German or English

Module name	**Advanced Seminar Physics**
Module label	HSB
Module responsible person of contact	Physics lecturers Lecturers of each course as listed in the course catalogue
Learning objectives	• Independent exploration of a current topic in physics • Understanding of physical methods • Development of presentation techniques • Ability to communicate technical subject matter in physics to a lecture hall of students in the form of a presentation
Content	Literature study of a predetermined topic chosen by the lecturer, draft of a presentation on this topic, presentation to a lecture hall of students; the topic can be adapted to fit the specialisation.
Key transferable skills	Presentation techniques, handling foreign-language literature, literature research
Duration	1 semester
Teaching format and scope	Advanced seminar (2 hr/week)
Credit	6
Grading	Written draft and presentation (ungraded assessment)
Student workload	Attendance: 30 hours; Topic draft and preparation of presentation 150 hours
Applicability	This module acts as a bridge between the acquisition of specific existing technical knowledge in the FEP, FTP, SCP, SPP, WFA, WFB modules, independent scientific work in the PPS and LPS modules, and independent research activity in the MA module.
Availability	Yearly in the winter and summer semesters
Language	German or English

Module name	**Project Seminar**
Module label	PPS
Module responsible	Physics lecturers
Learning objectives	Independent exploration of the theoretical and experimental background of a sub-domain of current research in physics
Content	Literature study in one sub-domain of current physics research
Key transferable skills	Handling foreign-language literature and problem-oriented preparation of complex subject matter, literature research
Duration	1 semester
Teaching format and scope	Advanced seminar (10 hr/week)
Credit	15
Grading	Presentation (ungraded assessment).
Student workload	Attendance: 150 hours; Topic preparation: 300 hours
Applicability	This module provides a platform for practising independent scientific working procedures, in preparation of independent research work in the MA module.
Availability	Yearly in the winter and summer semesters
Language	German or English

Module name	**Teaching/Research Project**
Module label	LPS
Module responsible	Physics lecturers
Learning objectives	Ability to work independently with modern experimental or theoretical methods in physics
Content	Exploration of the experimental, theoretical, or computational methods of a sub-domain of current research in physics.
Key transferable skills	Teamwork, application-oriented use of computers for data processing and simulation, and practical skills related to measurement techniques, literature research and handling of foreign-language literature, utilization of software packages (graphical, word processing, EDP) and programming tools.
Duration	1 semester
Teaching format and scope	Advanced seminar (10 hr/week)
Credit	15
Grading	Presentation (ungraded assessment)
Student workload	Attendance: 150 hours; Topic preparation: 300 hours
Applicability	This module provides a platform for practising independent scientific working procedures, in preparation of independent research work in the MA module.
Availability	Yearly in the winter and summer semesters
Language	German or English

Module name	**Master's Thesis**
Module label	MA
Module responsible	Physics lecturers
Learning objectives	Independent scientific problem-solving
Content	• Independent realization of scientific investigations • Representation of findings in a written report
Key transferable skills	Problem-solving strategies in relation to measurement apparatus and computers, organizational and planning competencies, utilization of software packages (graphics, word processing, EDP) and programming tools. Whenever possible, the presentation of one's own research findings in the context of national or international conferences will be an objective.
Duration	1 semester
Teaching format and scope	Collaboration within a physics research workgroup
Credit	30
Grading	Written report (master's thesis)
Student workload	900 hours
Applicability	This module builds on all other mandatory modules of this programme. It constitutes an independent stage of study, and is not applicable as part of another programme.
Availability	Yearly in the winter and summer semesters
Language	German or English

II. List of courses for the Master's Programme Physics

Please note: Some courses are combinations of lectures, see acronyms in the table below. Exams of combined lecture course cannot be dissected and distributed into individual lectures for the Master certificate afterwards. Details on the exam modalities for each course are defined by the respective lecturer(s).

Abbreviations:
SWS = hours per week
VX = X hours of lectures per week
ÜX = X hours of exercises per week
PX = X hours of lab training per week

A Physics Courses

A.1 Courses Offered Annually

a) Winter semester:

Course	Abbr.	Combo of	Eligible for modules	SWS	ECTS
Advanced Biological Physics		BP1+BP2	SCP, WFA	6	9
Advanced Quantum Mechanics			FTP, SCP, WFA	6	9
Mechanics of Continua			FTP, SCP, WFA	6	9
Advanced Experimental Physics[1]			FEP	4	6
Experimental and Statistical Biological Physics (Biological Physics C)	BP1		SCP, SPP, WFA, WFB	4	6
Collective Phenomena in Solids			SCP, SPP, WFA, WFB	4	6
Polymer Physics			SCP, SPP, WFA, WFB	4	6
Pattern Formation and Calculus in Nonlinear Physics		ND2+ND5	SCP, SPP, WFA, WFB	4	6
Experimental Methods in Biological Physics (Biological Physics B)	BP2		SCP, SPP, WFA, WFB	2	3
Laser			SCP, SPP, WFA, WFB	2	3
Calculus in Nonlinear Physics	ND5		*Crediting only in combination with ND2 or ND1+ND2*	Ü2	
Pattern Formation	ND2		SCP, SPP, WFA, WFB	2	3

[1]NEW, starting with winter semester 2020/2021 the only course for the FEP module

b) Summer semester:

Course	Abbr.	Combo of	Eligible for modules	SWS	ECTS
Non-Equilibrium Thermodynamics			FTP, SCP, WFA	6	9
Optical and Electronic Spectroscopy of Soft Matter		OS1+OS2 +OH2	SCP, WFA	6	9
Photophysics of Organic Semiconductors		OH1+OH2 +OS2	SCP, WFA	6	9
Quantum Theory of Condensed Matter			FTP, SCP, WFA	6	9
Computics (M.Sc.)			SCP, SPP, WFA, WFB	4	6
Organic Semiconductors		OH1+OH2	SCP, SPP, WFA, WFB	4	6
Spectroscopy of Soft Condensed Matter		OS1+OS2	SCP, SPP, WFA, WFB	4	6
Ferrofluid Dynamics	ND4		SCP, SPP, WFA, WFB	2	3
Principles of Optical Spectroscopy	OS1		SCP, SPP, WFA, WFB	2	3
Coherent Spectroscopy	OS2		SCP, SPP, WFA, WFB	2	3
Optical Properties of Organic Semiconductors	OH1		SCP, SPP, WFA, WFB	2	3
Physics of Organic Semiconductors Devices	OH2		SCP, SPP, WFA, WFB	2	3
Plasmonics and Nanooptics			SCP, SPP, WFA, WFB	2	3

A.2 Further Courses in Physics

Course	Eligible for modules	SWS	ECTS
Nonlinear Dynamics and Methods (ND1+ND2+ND5)	SCP, WFA	6	9
Acoustics: From Fundamentals to Applications	SCP, SPP, WFA, WFB	4	6
Crystallography in Solid State Physics	SCP, SPP, WFA, WFB	4	6
General Relativity	SCP, SPP, WFA, WFB	4	6
Hydrodynamics of Complex Fluids	SCP, SPP, WFA, WFB	4	6
Introduction to Quantum Density Functional Theory	SCP, SPP, WFA, WFB	4	6
Introduction to Cell Mechanics	SCP, SPP, WFA, WFB	4	6
Nonlinear Dynamics and Ferrofluids (ND1+ND4)	SCP, SPP, WFA, WFB	4	6
Nonlinear Dynamics and Pattern Formation (ND1+ND2)	SCP, SPP, WFA, WFB	4	6
Nuclear and Energy Physics	SCP, SPP, WFA, WFB	4	6
Nuclear Magnetic Resonance Spectroscopy	SCP, SPP, WFA, WFB	4	6
Pattern Formation in Living Matter	SCP, SPP, WFA, WFB	4	6
Physics of Complex Systems	SCP, SPP, WFA, WFB	4	6
Power Functional Theory for Many-Body Dynamics	SCP, SPP, WFA, WFB	4	6
Quantum Fluids	SCP, SPP, WFA, WFB	4	6
Quantum Optics	SCP, SPP, WFA, WFB	4	6
Spectroscopy of Biological Systems	SCP, SPP, WFA, WFB	4	6
Stochastic Processes in Physics	SCP, SPP, WFA, WFB	4	6
Astrophysics	SCP, SPP, WFA, WFB	2	3
Classical density functional theory	SCP, SPP, WFA, WFB	2	3
Climate physics	SCP, SPP, WFA, WFB	2	3
Electronic excitations of condensed matter with many-body perturbation theory	SCP, SPP, WFA, WFB	2	3
Introduction to Fusion Research	SCP, SPP, WFA, WFB	2	3
Introduction to Plasma Physics	SCP, SPP, WFA, WFB	2	3
Introduction to Research in Nuclear Fusion	SCP, SPP, WFA, WFB	2	3
Introduction to the Physics of Cellular Signal Processing	SCP, SPP, WFA, WFB	2	3
Introduction to the Theory of Relativity	SCP, SPP, WFA, WFB	2	3
Molecular Dynamics in Biophysical Systems	SCP, SPP, WFA, WFB	2	3
Nonlinear Dynamics (ND1)	SCP, SPP, WFA, WFB	2	3
Nonlinear Optics	SCP, SPP, WFA, WFB	2	3
Optical and electronic properties of inorganic Semi-conductors	SCP, SPP, WFA, WFB	2	3
Pathintegrals	SCP, SPP, WFA, WFB	2	3
Physics of Embryogenesis	SCP, SPP, WFA, WFB	2	3
Scattering Methods for Soft Matter Systems	SCP, SPP, WFA, WFB	2	3

Surface and Nanophysics	SCP, SPP, WFA, WFB	2	3
Superconductivity / Theory of Superconductivity	SCP, SPP, WFA, WFB	2	3
Synchrotron Radiation and the Free Electron Laser	SCP, SPP, WFA, WFB	2	3
Theoretical Nonlinear Optics	SCP, SPP, WFA, WFB	2	3
Ultrafast Photonics	SCP, SPP, WFA, WFB	2	3

B. Non-Physics courses

Course	Eligible for module	SWS	ECTS
Advanced Mathematics for Physicists	WFA	6	9
Biochemical Physics	WFA, WFB	4	6
Genetics of Eukaryotes	WFA, WFB	V2	4
Genetics of Eukaryotes	WFA, WFB	S2	2
Genetics of Eukaryotes	WFA, WFB	P5	3
Physics of Materials	WFA, WFB	4	6
Structure analysis of crystalline matter	WFA, WFB	4	6
Colloids and Interfaces	WFA, WFB	V2	4
Physical Chemistry of Polymers	WFA, WFB	V2	4
Crystallography in Superspace	WFA, WFB	2	3
Evolutionary Biology and Population Genetics	WFA, WFB	2	3
Advanced Physical Chemistry	WFA, WFB	2	3
Principles of Energy Conversion I	WFA, WFB	2	3
Principles of Energy Conversion II	WFA, WFB	2	3
Meteorology	WFA, WFB	V2+Ü1	3
Sensors	WFA, WFB	2	3
Cell Biology	WFA, WFB	2	3
Practical Course Module P103/ C104[1]	WFA, WFB	P6	2
Practical Course: Physical Chemistry (P102/C103)[2]	WFA, WFB	P6	2

Remarks:

[1]The 'Practical Course Module P103 / C104' is connected to the lecture 'Colloids and Interfaces'.

[2] The 'Practical Course: Physical Chemistry (P102/C103)' is connected to the lecture 'Physical Chemistry of Polymers' (up to the winter term 2016/2017, its title was 'Practical Course: Physical Chemistry of Polymers').