LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Module Catalogue

Bachelor's Program: Physics

(Bachelor of Science, B.Sc.)

(180 ECTS points)

On the basis of the Examination- and Study Regulations

adopted by the Senate of the LMU Munich on June 22, 2023

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Abbreviations and annotations

CP	Credit points, ECTS points
ECTS	European Credit Transfer and Accumulation System
h	hours
SoSe	Summer semester
WiSe	WiSe
SWS	contact hours
WP	elective course/module
P	mandatory course/module

1. The description of the assigned module parts is based on the following scheme with regard to the respective ECTS points: ECTS points not in brackets are awarded upon passing the associated module examination or partial module examination. ECTS points in brackets are only used for mathematical allocation.

2. Depending on the information in Annex 2 of the Examination and Study Regulations, the information on the Semester may be fixed regulations or mere recommendations. This is indicated in the module handbook by the terms "scheduled semester" and "recommended semester".

3. Please note: The Module Catalogue is merely intended to serve as an orientation whereas the provisions of the applicable version of the Prüfungs- und Studienordnung (in German only) of your Programme are legally binding. See: www.lmu.de/studienangebot and select your Programme.

Module: P 1 Experimental Physics I: Mechanics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 1.1 Lecture Mechanics	WiSe	60 h (4 SWS)	120 h	(6)
Exercise	P 1.2 Exercise for the lecture Mechanics	WiSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; BSc Geowissenschaften
Elective guidlines	none
Entry requirements	none
Semester	Scheduled semester: 1
Duration	The module extends over 1 semester.
Content	Concepts and experimental methods in mechanics: Newtonian mechanics, vibrations and waves, motion of rigid bodies, mechanics of deformable bodies, hydrostatics, hydrodynamics, special relativity.
Learning outcomes	The main learning objectives are knowledge and understanding of the above learning content, the ability to apply it and link it together. In addition, familiarity with methods of experimental physics and the ability to interpret, verify or falsify experimental results are general learning objectives. Students should become aware of the connection to phenomena in nature and to current research.
Type of examination	Written examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German

Additional information	None

Module: P 2 Computational Methods in Theoretical Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 2.1 Lecture Computational Methods in Theoretical Physics	WiSe	60 h (4 SWS)	120 h	(6)
Exercise	P 2.2 Exercise for the lecture Computational Methods in Theoretical Physics	WiSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The contact hours is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; BSc Geowissenschaften; Unterrichtsfach Physik für das Lehramt an Gymnasien; Unterrichtsfach Physik für das Lehramt an Realschulen
Elective guidlines	None
Entry requirements	None
Semester	Scheduled semester: 1
Duration	The module extends over 1 semester.
Content	Provision of calculation methods required in theoretical physics: complex numbers, vector analysis, coordinate transformations; matrices, eigenvalue problems; differentiation and integration of functions of one and several variables, distributions, Fourier analysis, approximation methods, differential equations; integral theorems of Gauss and Stokes.
Learning outcomes	The main learning objectives are knowledge and understanding of mathematical methods and calculation skills in physics. The ability to apply these methods to physical problems is of central importance.
Type of examination	Written examination
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft

Language(s)	German
Additional information	None

Module: P 3 Mathematics I: Linear Algebra

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 3.1 Lecture Linear Algebra	WiSe	60 h (4 SWS)	120 h	(6)
Exercise	P 3.2 Exercise for the lecture Linear Algebra	WiSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The Contact hours is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; BSc Geowissenschaften
Elective guidlines	None
Entry requirements	None
Semester	Recommended semester: 1
Duration	The module extends over 1 semester.
Content	Mathematical concepts and methods of linear algebra for students of physics. Basic concepts of linear algebra, vector space, linear mappings, matrices and determinants, eigenvalues and eigenvectors, diagonalization of matrices and principal axis transformation.
Learning outcomes	The main learning objectives are knowledge and understanding of mathematical methods in physics. The ability to apply these methods to physical problems is of central importance.
Type of examination	Written examination
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German
Additional information	None

Module: P 4 Basic Lab Course in Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lab course	P 4.1 Basic practical course in physics 1	WiSe	30 h (2 SWS)	60 h	(3)
Lab course	P 4.2 Basic practical course in physics 2	SoSe	30 h (2 SWS)	60 h	(3)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; Unterrichtsfach Physik für das Lehramt an Gymnasien
Elective guidlines	None
Entry requirements	None
Semester	Recommended semester: 1 and 2
Duration	The module extends over 2 semesters.
Content	Practical experiments, particularly in the areas of *mechanics*, *thermodynamics and electromagnetism*.
Learning outcomes	Ability to examine physical laws on the basis of simple experiments, competence in the practical use of experimental equipment, ability to document scientifically, critical evaluation of experimental results, introduction to scientific working methods. Familiarity with the use of physical equipment and the connection to theoretical knowledge are general learning objectives.
Type of examination	Scientific protocol
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dr. Jürgen Durst
Language(s)	German
Additional information	None

Module: P 5 Experimental Physics II: Heat and Electromagnetism

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 5.1 Lecture on heat and electromagnetism	SoSe	60 h (4 SWS)	120 h	(6)
Exercise	P 5.2 Exercise for the lecture Heat and Electromagnetism	SoSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	Unterrichtsfach Physik für das Lehramt an Gymnasien
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 2
Duration	The module extends over 1 semester.
Content	Concepts and experimental methods in heat and electromagnetism: kinetic theory of gases, laws of thermodynamics, transport processes, electrostatics, magnetism, alternating currents, Maxwell's equations.
Learning outcomes	The main learning objectives are knowledge and understanding of the above learning content, the ability to apply it and link it together. In addition, familiarity with methods of experimental physics and the ability to interpret, verify or falsify experimental results are general learning objectives. Students should become aware of the connection to phenomena in nature and to current research.
Type of examination	Written examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German

Additional information none

Module: P 6 Theoretical Physics I: Theoretical Mechanics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 6.1 Lecture Theoretical Mechanics	SoSe	60 h (4 SWS)	120 h	(6)
Exercise	P 6.2 Exercise for the lecture Theoretical Mechanics	SoSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	none
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 2
Duration	The module extends over 1 semester.
Content	Concepts and theoretical methods of mechanics: Physical foundations of mechanics, Newtonian, Langrangian and Hamiltonian formulations of mechanics and their application to mechanical problems (e.g. motion of mass points in central force fields, rigid bodies, small oscillations).
Learning outcomes	The main learning objectives are knowledge and understanding of the above learning content and the mathematics required for this, as well as the ability to apply the learning content and link it to one another. In addition, familiarity with methods of theoretical physics and the ability to create models and deduce results from models are general learning objectives. Students should become aware of the connection to phenomena in nature and to current research.
Type of examination	Written examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft

Language(s)	German
Additional information	none

Module: P 7 Mathematics II: Analysis I

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 7.1 Lecture Analysis 1	SoSe	60 h (4 SWS)	120 h	(6)
Exercise	P 7.2 Exercise for the lecture Analysis 1	SoSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; BSc Geowissenschaften
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 2
Duration	The module extends over 1 semester.
Content	Mathematical concepts and methods of analysis for students of physics. Sequences and series, limits, basic concepts of differential and integral calculus of functions of one variable, basic concepts of multivariate differential and integral calculus, line-, surface- and volume-integrals, fundamental theorem of multivariate calculus.
Learning outcomes	The main learning objectives are knowledge and understanding of mathematical methods in physics. The ability to apply these methods to physical problems is of central importance.
Type of examination	Written examination
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German
Additional information	none

Module: P 8 Experimental Physics III: Electromagnetic Waves and Optics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 8.1 Lecture Electromagnetic Waves and Optics	WiSe	60 h (4 SWS)	120 h	(6)
Exercise	P 8.2 Exercise for the lecture Electromagnetic Waves and Optics	WiSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	Unterrichtsfach Physik für das Lehramt an Gymnasien
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 3
Duration	The module extends over 1 semester.
Content	Concepts and experimental methods in optics: electromagnetic waves, geometrical optics, reflection and transmission, absorption, polarization, wave optics, Fourier optics, diffraction and interference, applications (e.g. optical devices, interferometers).
Learning outcomes	The main learning objectives are knowledge and understanding of the above learning content, the ability to apply it and link it together. In addition, familiarity with methods of experimental physics and the ability to interpret, verify or falsify experimental results are general learning objectives. Students should become aware of the connection to phenomena in nature and to current research.
Type of examination	Written examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.

Responsible contact	Dean of Studies
Language(s)	German
Additional information	none

Module: P 9 Theoretical Physics II: Quantum Mechanics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 9.1 Lecture Quantum Mechanics	WiSe	60 h (4 SWS)	120 h	(6)
Exercise	P 9.2 Exercise for the lecture Quantum Mechanics	WiSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	none
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 3
Duration	The module extends over 1 semester.
Content	Concepts and theoretical methods of quantum mechanics: Physical foundations of quantum mechanics, mathematical representations of quantum mechanics, Schrödinger, Heisenberg and interaction picture, angular momentum and spin, applications to quantum systems (e.g. harmonic oscillator, hydrogen atom).
Learning outcomes	The main learning objectives are knowledge and understanding of the above learning content and the mathematics required for this, as well as the ability to apply the learning content and link it to one another. In addition, familiarity with methods of theoretical physics and the ability to create models and deduce results from models are general learning objectives. Students should become aware of the connection to phenomena in nature and to current research.
Type of examination	Written examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	The ECTS credits will be granted when the module examination has been completed successfully.

Responsible contact	Prof. Dr. Jan von Delft
Language(s)	German
Additional information	none

Module: P 10 Mathematics III: Analysis II

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 10.1 Lecture Analysis 2	WiSe	60 h (4 SWS)	120 h	(6)
Exercise	P 10.2 Exercise for the lecture Analysis 2	WiSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; BSc Geowissenschaften
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 3
Duration	The module extends over 1 semester.
Content	Mathematical concepts and methods of analysis for students of physics: linear and non-linear differential equations, complex analysis, in particular residue theorem, integral transformations.
Learning outcomes	The main learning objectives are knowledge and understanding of mathematical methods in physics. The ability to apply these methods to physical problems is of central importance.
Type of examination	Written examination
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German
Additional information	none

Module: P 11 Programming for Physics Students

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 11.1 Introduction to programming for physics students	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory module with compulsory course
Usabiltiy of the module in other programs	BSc Physik pus Meteorologie; Nebenfach Meteorologie im Umfang von 30 ECTS-Punkten für Bachelorstudiengänge
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 3
Duration	The module extends over 1 semester.
Content	Basic concepts of programming languages, understanding the flow of programs, creating small programs.
Learning outcomes	The learning objectives are the ability to create small programs and to acquire the basic knowledge to understand, use and further develop programs.
Type of examination	Written or oral examination or presentation
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German
Additional information	none

Module: P 12 Experimental Physics IV: Atomic and Molecular Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 12.1 Lecture Atomic and Molecular Physics	SoSe	60 h (4 SWS)	120 h	(6)
Exercise	P 12.2 Exercise for the lecture Atomic and Molecular Physics	SoSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	none
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 4
Duration	The module extends over 1 semester.
Content	Concepts and experimental methods of atomic and molecular physics: Planckian radiation, Bohr-Sommerfeld quantum mechanics, hydrogen atom, multi-electron atoms, atoms in external fields, spectroscopy, X-rays, molecular physics.
Learning outcomes	The main learning objectives are knowledge and understanding of the above learning content, the ability to apply it and link it together. In addition, familiarity with methods of experimental physics and the ability to interpret, verify or falsify experimental results are general learning objectives. Students should become aware of the connection to phenomena in nature and to current research.
Type of examination	Written examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies

Language(s)	German
Additional information	none

Module: P 13 Theoretical Physics III: Electrodynamics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 13.1 Lecture Electrodynamics	SoSe	60 h (4 SWS)	120 h	(6)
Exercise	P 13.2 Exercise for the lecture Electrodynamics	SoSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	none
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 4
Duration	The module extends over 1 semester.
Content	Concepts and theoretical methods of electrodynamics: physical foundations of electrodynamics, Maxwell's equations, static, stationary and quasi-stationary problems, electromagnetic radiation, covariant formulation, electrodynamics in matter.
Learning outcomes	The main learning objectives are knowledge and understanding of the above learning content and the mathematics required for this, as well as the ability to apply the learning content and link it to one another. In addition, familiarity with methods of theoretical physics and the ability to create models and deduce results from models are general learning objectives. Students should become aware of the connection to phenomena in nature and to current research.
Type of examination	Written examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	The ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft

Language(s)	German
Additional information	none

Module: P 14 Numerical Methods and Data Analysis in Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 14.1 Lecture Numerical Methods and Data Analysis in Physics	SoSe	45 h (3 SWS)	75 h	(4)
Exercise	P 14.2 Exercise for the lecture Numerical Methods and Data Analysis in Physics	SoSe	15 h (1 SWS)	45 h	(2)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; BSc Geowissenschaften
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 4
Duration	The module extends over 1 semester.
Content	Numerical mathematics and methods of data analysis. Possible topics include interpolation, approximation, non-linear equations, linear systems of equations, eigenvalue problems, numerical integration, initial value problems, curve fitting and least squares, parameter estimation and confidence intervals, model selection and hypothesis testing.
Learning outcomes	The main learning objectives are knowledge and understanding of numerical methods and methods of data analysis in physics. The ability to apply these methods to physical problems and analyses in experimental physics is of central importance.
Type of examination	Written examination
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German

Additional information none

Module: P 15 Advanced Lab Course in Physics I

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lab course	P 15.1 Advanced practical course in physics 1 (part A)	SoSe	30 h (2 SWS)	60 h	(3)
Lab course	P 15.2 Advanced practical course in physics 1 (part B)	WiSe	30 h (2 SWS)	60 h	(3)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	Unterrichtsfach Physik für das Lehramt an Gymnasien
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 4 and 5
Duration	The module extends over 2 semesters.
Content	Practical experiments, particularly in the areas of *atomic and molecular physics* as well as *electromagnetic waves and optics*.
Learning outcomes	Ability to examine physical laws on the basis of simple experiments, proficiency in the practical use of experimental equipment, skills in scientific documentation, in critical evaluation of experimental results, introduction to scientific working methods. Familiarity with the use of physical equipment and the connection to theoretical knowledge are general learning objectives.
Type of examination	scientific protocol
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dr. Jürgen Durst
Language(s)	German

Additional information	none

Module: WP 1 Key Qualifications I

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 1.1 Key qualifications for Bachelor students 1	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Elective module with compulsory course
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie
Elective guidlines	The module can be selected in accordance with the following rules: One compulsory elective module must be selected from the compulsory elective modules WP 1 to WP 3. At least the following languages at different levels are available for the compulsory elective module WP 3: Arabic, Chinese, English, French, Italian, Japanese, Dutch, Norwegian, Portuguese, Swedish, Spanish, Thai and Turkish.
Entry requirements	none
Semester	Recommended semester: 4
Duration	The module extends over 1 semester.
Content	In addition to the specialist qualification in physics, the module imparts knowledge that is particularly relevant to the profession of physicist, e.g. programming, science communication, patenting, founding a company.
Learning outcomes	Students gain insights into the topics mentioned; depending on the topic chosen, skills for application are practiced.
Type of examination	Written or oral examination or presentation
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German

Additional information none

Module: WP 2 Key Qualifications II

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Seminar	WP 2.1 Key qualifications for Bachelor students 2	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Elective module with compulsory course
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie
Elective guidlines	The module can be selected in accordance with the following rules: One compulsory elective module must be selected from the compulsory elective modules WP 1 to WP 3. At least the following languages at different levels are available for the compulsory elective module WP 3: Arabic, Chinese, English, French, Italian, Japanese, Dutch, Norwegian, Portuguese, Swedish, Spanish, Thai and Turkish.
Entry requirements	none
Semester	Recommended semester: 4
Duration	The module extends over 1 semester.
Content	In addition to the specialist qualification in physics, the module imparts knowledge that is particularly relevant to the profession of physicist, e.g. programming, science communication, patenting, founding a company.
Learning outcomes	Students gain insights into the topics mentioned; depending on the chosen topic, skills for application are practiced.
Type of examination	Written or oral examination or presentation
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German

Additional information	none

Module: WP 3 Modern Foreign Languages

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Exercise	WP 3.1 Language course in a modern foreign language	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Elective module with compulsory course
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie
Elective guidlines	The module can be selected in accordance with the following rules: One compulsory elective module must be selected from the compulsory elective modules WP 1 to WP 3. At least the following languages at different levels are available for the compulsory elective module WP 3: Arabic, Chinese, English, French, Italian, Japanese, Dutch, Norwegian, Portuguese, Swedish, Spanish, Thai and Turkish.
Entry requirements	none
Semester	Recommended semester: 4
Duration	The module extends over 1 semester.
Content	The module imparts knowledge of a modern foreign language. Students can choose from a variety of language courses at different levels.
Learning outcomes	Students acquire foreign language skills in a modern foreign language of their choice and at a level of their choice.
Type of examination	Written or oral examination or presentation
Type of assessment	The module is not graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German

Additional information none

Module: P 16 Experimental Physics V: Nuclear and Particle Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 16.1 Lecture Nuclear and Particle Physics	WiSe	45 h (3 SWS)	75 h	(4)
Exercise	P 16.2 Exercise for the lecture Nuclear and Particle Physics	WiSe	15 h (1 SWS)	45 h	(2)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; Unterrichtsfach Physik für das Lehramt an Gymnasien; Nebenfach Physik im Umfang von 60 ECTS-Punkten für Bachelorstudiengänge
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	Concepts and experimental methods of nuclear and particle physics: structure of atomic nuclei, nuclear reactions and nuclear decays, instruments of nuclear and particle physics, interactions and decays of hadrons, elementary particles and fundamental interactions.
Learning outcomes	The main learning objectives are knowledge and understanding of the above learning content, the ability to apply it and link it together. In addition, familiarity with methods of experimental physics and the ability to interpret, verify or falsify experimental results are general learning objectives. Students should become aware of the connection to phenomena in nature and to current research.
Type of examination	Written examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.

Responsible contact	Dean of Studies
Language(s)	German
Additional information	none

Module: P 17 Experimental Physics VI: Solid State Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 17.1 Lecture Solid State Physics	WiSe	45 h (3 SWS)	75 h	(4)
Exercise	P 17.2 Exercise for the lecture Solid State Physics	WiSe	15 h (1 SWS)	45 h	(2)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; Unterrichtsfach Physik für das Lehramt an Gymnasien; Nebenfach Physik im Umfang von 60 ECTS-Punkten für Bachelorstudiengänge
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	Concepts and experimental methods of solid state physics: crystal structures, lattice vibrations, mechanical, thermal, dielectric, magnetic and optical properties of crystalline solids, insulators, semiconductors, metals, superconductivity.
Learning outcomes	The main learning objectives are knowledge and understanding of the above learning content, the ability to apply it and link it together. In addition, familiarity with methods of experimental physics and the ability to interpret, verify or falsify experimental results are general learning objectives. Students should become aware of the connection to phenomena in nature and to current research.
Type of examination	Written examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies

Language(s)	German
Additional information	none

Module: P 18 Theoretical Physics IV: Statistical Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 18.1 Lecture Statistical Physics	WiSe	60 h (4 SWS)	120 h	(6)
Exercise	P 18.2 Exercise for the lecture Statistical Physics	WiSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Compulsory module with compulsory courses
Usabiltiy of the module in other programs	none
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	Concepts and theoretical methods of statistical physics: fundamentals of statistical physics, statistical and phenomenological thermodynamics, applications (e.g. classical many-body systems, phase transitions, quantum gases).
Learning outcomes	The main learning objectives are knowledge and understanding of the above learning content and the mathematics required for this, as well as the ability to apply the learning content and link it to one another. In addition, familiarity with methods of theoretical physics and the ability to create models and deduce results from models are general learning objectives. Students should become aware of the connection to phenomena in nature and to current research.
Type of examination	Written examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft

Language(s)	German
Additional information	none

Module: WP 4 Introduction to Research of Experimental physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 4.1 Lecture Introduction to research in experimental physics	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise	WP 4.2 Exercise for the lecture Introduction to Research in Experimental Physics	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Elective module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; Unterrichtsfach Physik für das Lehramt an Gymnasien; Unterrichtsfach Physik für das Lehramt an Realschulen; Unterrichtsfach Physik für das Lehramt an Mittelschulen; Unterrichtsfach Physik für das Lehramt an Grundschulen
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	The module offers an introduction to selected research topics in experimental physics.
Learning outcomes	Students acquire basic knowledge and understanding of the content covered.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.

Responsible contact	Dean of Studies
Language(s)	German
Additional information	None

Module: WP 5 Insights into Current Research Fields of Experimental Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 5.1 Lecture Insights into current research fields of experimental physics	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory elective module with compulsory course
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; Unterrichtsfach Physik für das Lehramt an Gymnasien; Unterrichtsfach Physik für das Lehramt an Realschulen
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	The module provides exemplary insights into current research fields of experimental physics.
Learning outcomes	Students acquire basic knowledge and understanding of the content covered.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German

Additional information	None

Module: WP 6 Introduction to Research of Theoretical Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 6.1 Lecture Introduction to research in theoretical physics	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise	WP 6.2 Exercise for the lecture Introduction to Research in Theoretical Physics	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Elective module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; Unterrichtsfach Physik für das Lehramt an Gymnasien; Unterrichtsfach Physik für das Lehramt an Realschulen
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	None
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	The module provides an introduction to selected research topics in theoretical physics.
Learning outcomes	Students acquire basic knowledge and understanding of the content covered.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft

Language(s)	German
Additional information	None

Module: WP 7 Insights into Current Research Fields of Theoretical Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 7.1 Lecture Insights into current research fields of theoretical physics	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory elective module with compulsory course
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; Unterrichtsfach Physik für das Lehramt an Gymnasien; Unterrichtsfach Physik für das Lehramt an Realschulen
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	None
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	The module provides exemplary insights into current fields of research in theoretical physics.
Learning outcomes	Students acquire basic knowledge and understanding of the content covered.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft
Language(s)	German

Additional information	None

Module: WP 8 Introduction to Computer Science: Programming and Software Development

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 8.1 Lecture Introduction to Computer Science: Programming and Software Development	WiSe	45 h (3 SWS)	45 h	(3)
Exercise	WP 8.2 Exercise on Introduction to Computer Science: Programming and Software Development	WiSe	30 h (2 SWS)	60 h	(3)

A total of 6 ECTS credits must be earned in the module. The attendance time is 5 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Elective module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	None
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	This module provides an introduction to the basic terms and concepts of computer science. Techniques for the representation, structuring and processing of data and for the development of algorithms are covered. This module also provides an introduction to object-oriented programming with which the concepts learned are put into practice. Emphasis is placed on conceptual clarity and a precise mathematical foundation. In detail, the following are taught: • Basic concepts of programs and their execution, • Syntax of programming languages and their description, • Basic data types and composite data structures, • Design and discussion of algorithms: Searching, sorting,

	• Imperative control structures, • Introduction to object-oriented program design, • Object-oriented structuring principles: Classes, Interfaces, inheritance, modules, • Complexity and correctness of imperative programs. The module consists of a lecture and exercises in small groups. The content discussed in the lecture is practiced in the practical part using practical applications.
Learning outcomes	Students will be able to algorithmically implement solutions for smaller and manageable problems and realize them as executable programs using a higher programming language. Furthermore, students develop an understanding of the general principles of programming and programming languages.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	The ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Dirk Beyer
Language(s)	German
Additional information	none

Module: WP 9 Introduction to Artificial Intelligence I

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 9.1 Lecture Introduction to Artificial Intelligence 1	WiSe	45 h (3 SWS)	75 h	(4)
Exercise	WP 9.2 Exercise for the lecture Introduction to Artificial Intelligence 1	WiSe	15 h (1 SWS)	45 h	(2)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Elective module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	It is recommended that basic knowledge of mathematics, statistics and programming, especially with Python, is available (modules 1, 2 and 3 from the 60-ECTS AI minor).
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	The lecture provides an introduction to the methodological foundations of artificial intelligence. The following topics are covered, among others: Intelligent agents, knowledge representation, problem solving through search, knowledge processing with constraints, rational action and machine learning.
Learning outcomes	Upon completion of this module, students will have an understanding of basic concepts and selected topics in Artificial Intelligence and will have an overview of current developments, trends and emerging issues in AI.
Type of examination	Written or oral examination

Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Eyke Hüllermeier
Language(s)	German
Additional information	none

Module: WP 10 General and Inorganic Chemistry for Physics Students and Minor Subject Students

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 10.1 Lecture on general and inorganic chemistry for physics students and minor students	WiSe	45 h (3 SWS)	75 h	(4)
Exercise	WP 10.2 Exercise for the lecture General and Inorganic Chemistry for students of physics and minor subject students	WiSe	15 h (1 SWS)	45 h	(2)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Elective module with compulsory courses
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	None
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	Structure of matter: atomic nucleus & electron shell; molecules through atomic bonding; basics of nuclear dynamics & spectroscopy; chemical reactions: Redox, acid-base and equilibrium reactions; energy balances of reactions; structure of periodic solids (packing of spheres); atomic and molecular gases; production and properties of metals.
Learning outcomes	Confident handling of basic concepts of chemistry: setting up chemical equations; evaluation of reaction processes; basic knowledge of atomic, molecular and periodic structures.
Type of examination	Written or oral examination

Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dr. Thomas Bräuniger
Language(s)	German
Additional information	None

Module: WP 11 Physics Project Lab Course

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lab course	WP 11.1 Physics project lab course for Bachelor and teacher training students	WiSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory elective module with compulsory course
Usabiltiy of the module in other programs	BSc Physik plus Meteorologie; Physik für das Lehramt an Gymnasien
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 5
Duration	The module extends over 1 semester.
Content	Independent processing of smaller research topics chosen by the student - possibly from a pool of ideas. Set-ups and experimental procedures must be developed by the students themselves and the measurements obtained must be evaluated. A high degree of independence and direct practical relevance should lead to particular motivation on the part of the students.
Learning outcomes	Design, planning, construction, implementation and evaluation of physical experiments; design of own experiments; use of digital data acquisition systems; preparation of a risk assessment; literature research on experimental and theoretical principles of self-selected questions; critical error analysis and discussion of measurement uncertainties; ability to work scientifically in a small team (2-6 people); presentation of measurement results using modern presentation tools.

Type of examination	Presentation
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dr. Jürgen Durst
Language(s)	German
Additional information	none

Module: P 19 Advanced Lab Course in Physics II

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lab course	P 19.1 Advanced lab course in physics 2	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory module with compulsory course
Usabiltiy of the module in other programs	none
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	Advanced experiments on current research areas of the Faculty of Physics.
Learning outcomes	Students have the ability to independently familiarize themselves with several defined research areas of physics and to carry out scientific experiments, analyze them and document the results obtained.
Type of examination	Scientific protocol
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dr. Martin Benoit
Language(s)	German
Additional information	none

Module: P 20 Final module

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Bachelor thesis	P 20.1 Bachelor thesis	WiSe and SoSe	-	360 h	(12)
Disputation	P 20.2 Disputation	WiSe and SoSe	-	90 h	(3)

A total of 15 ECTS credits must be earned in the module. The attendance time is 0 semester hours per week. Including self-study, approximately 450 hours must be spent.

Module type	Compulsory module
Usabiltiy of the module in other programs	none
Elective guidlines	none
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	In the Bachelor's thesis, a narrowly defined physics topic is developed and presented within 12 weeks with the help of specified literature. As part of the subsequent defense, questions about the Bachelor's thesis must be answered in an oral examination.
Learning outcomes	Students learn techniques of scientific work in physics that enable them to present a narrowly defined topic in writing, taking into account scientific standards.
Type of examination	Bachelor thesis and defense
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German
Additional information	none

Module: WP 12 Basic Research Concepts of Experimental Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 12.1 Lecture Fundamental research concepts in experimental physics	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Exercise	WP 12.2 Exercise for the lecture Fundamental Research Concepts in Experimental Physics	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Elective module with compulsory courses
Usabiltiy of the module in other programs	Unterrichtsfach Physik für das Lehramt an Realschulen
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	The module deals with examples of fundamental research concepts in experimental physics.
Learning outcomes	Students acquire basic knowledge and understanding of the content covered.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies

Language(s)	German
Additional information	none

Module: WP 13 Current Research Designs of Experimental Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 13.1 Lecture Current research designs in experimental physics	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise	WP 13.2 Exercise for the lecture Current research designs in experimental physics	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Elective module with compulsory courses
Usabiltiy of the module in other programs	Unterrichtsfach Physik für das Lehramt an Realschulen
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	The module deals with examples of current research designs in experimental physics.
Learning outcomes	Students acquire basic knowledge and understanding of the content covered.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies

Language(s)	German
Additional information	none

Module: WP 14 Special Research Approaches of Experimental Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 14.1 Lecture Special Research Approaches in Experimental Physics	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory elective module with compulsory course
Usabiltiy of the module in other programs	Unterrichtsfach Physik für das Lehramt an Gymnasien; Unterrichtsfach Physik für das Lehramt an Realschulen
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	The module deals with examples of special research approaches in experimental physics.
Learning outcomes	Students acquire basic knowledge and understanding of the content covered.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German

Additional information	none

Module: WP 15 Basic Research Concepts of Theoretical Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 15.1 Lecture Fundamental research concepts in theoretical physics	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Exercise	WP 15.2 Exercise for the lecture Fundamental Research Concepts in Theoretical Physics	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 9 ECTS credits must be earned in the module. The attendance time is 6 semester hours per week. Including self-study, approximately 270 hours must be spent.

Module type	Elective module with compulsory courses
Usabiltiy of the module in other programs	Unterrichtsfach Physik für das Lehramt an Realschulen
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	The module deals with examples of fundamental research concepts in theoretical physics.
Learning outcomes	Students acquire basic knowledge and understanding of the content covered.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft

Language(s)	German
Additional information	none

Module: WP 16 Current Research Designs of Theoretical Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 16.1 Lecture Current research designs in theoretical physics	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise	WP 16.2 Exercise for the lecture Current research designs in theoretical physics	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Elective module with compulsory courses
Usabiltiy of the module in other programs	Unterrichtsfach Physik für das Lehramt an Realschulen
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	The module deals with examples of current research designs in theoretical physics.
Learning outcomes	Students acquire basic knowledge and understanding of the content covered.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft

Language(s)	German
Additional information	none

Module: WP 17 Special Research Approaches of Theoretical Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 17.1 Lecture Special Research Approaches in Theoretical Physics	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory elective module with compulsory course
Usabiltiy of the module in other programs	Unterrichtsfach Physik für das Lehramt an Gymnasien; Unterrichtsfach Physik für das Lehramt an Realschulen
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	The module deals with examples of special research approaches in theoretical physics.
Learning outcomes	Students acquire basic knowledge and understanding of the content covered.
Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft
Language(s)	German

Additional information	none

Module: WP 18 Introduction to Artificial Intelligence II

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 18.1 Lecture Introduction to Artificial Intelligence 2	SoSe	45 h (3 SWS)	75 h	(4)
Exercise	WP 18.2 Exercise for the lecture Introduction to Artificial Intelligence 2	SoSe	15 h (1 SWS)	45 h	(2)

A total of 6 ECTS credits must be earned in the module. The attendance time is 4 semester hours per week. Including self-study, approximately 180 hours must be spent.

Module type	Elective module with compulsory courses
Usabiltiy of the module in other programs	none
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	It is recommended that basic knowledge of mathematics, statistics and programming, especially with Python, is available (modules 1, 2 and 3 from the 60-ECTS AI minor).
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	The module introduces the basic concepts and methods of (supervised) machine learning. Starting with the concept of risk minimization using the example of the linear regression model, further learning methods such as logistic regression, KNN, decision trees and random forests are introduced. In addition, essential terms and concepts in supervised machine learning such as overfitting, underfitting, performance evaluation, resampling and hyperparameter tuning are introduced.
Learning outcomes	Students learn basic concepts and methods of supervised machine learning and are able to correctly evaluate the underlying models at and independently solve simple problems in machine learning.

Type of examination	Written or oral examination
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Bernd Bischl
Language(s)	German
Additional information	none

Module: WP 19 Discussion of Current Research Questions of Experimental Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Seminar	WP 19.1 Seminar Discussion of current research questions in experimental physics	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory elective module with compulsory course
Usabiltiy of the module in other programs	none
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	Students work on a topic from the field of experimental physics, present it to the seminar group and discuss conclusions.
Learning outcomes	Students further develop their ability to work independently on a new topic from the field of experimental physics using scientific literature. They deepen their skills in presenting scientific content in a structured and comprehensible way.
Type of examination	Presentation
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	The ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies

Language(s)	German
Additional information	none

Module: WP 20 Discussion of Current Research Questions of Theoretical Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Seminar	WP 20.1 Seminar Discussion of current research questions in theoretical physics	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory elective module with compulsory course
Usabiltiy of the module in other programs	none
Elective guidlines	The module can be selected in accordance with the following rules: Compulsory elective modules worth a total of 15 ECTS credits must be selected from the compulsory elective modules WP 4 to WP 20. Compulsory elective modules worth 6 ECTS credits should be chosen in the 5th semester and compulsory elective modules worth 9 ECTS credits in the 6th semester.
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	Students work on a topic from the field of theoretical physics, present it to the seminar group and discuss conclusions.
Learning outcomes	Students further develop their ability to work independently on a new topic from the field of theoretical physics using scientific literature. They deepen their skills in presenting scientific content in a structured and comprehensible manner.
Type of examination	Presentation
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	The ECTS credits will be granted when the module examination has been completed successfully.

Responsible contact	Prof. Dr. Jan von Delft
Language(s)	German
Additional information	none

Module: WP 21 Presentation of Exemplary Topics of Experimental Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Seminar	WP 21.1 Seminar Presentation of exemplary topics in experimental physics	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory elective module with compulsory course
Usabiltiy of the module in other programs	none
Elective guidlines	The module can be selected in accordance with the following rules: One compulsory elective module must be selected from the compulsory elective modules WP 21 and WP 22.
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	Students work on a topic from the field of experimental physics, present it to the seminar group and discuss conclusions.
Learning outcomes	Students further develop their ability to work independently on a new topic from the field of experimental physics using scientific literature. They deepen their skills in presenting scientific content in a structured and comprehensible way.
Type of examination	Presentation
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Dean of Studies
Language(s)	German
Additional information	none

Module: WP 22 Presentation of Exemplary Topics of Theoretical Physics

Program	Bachelor's Program: Physics (Bachelor of Science, B.Sc.)

Assigned module parts

Course type	Course (compulsary)	Rotation	Contact hours	Self-study hours	ECTS
Seminar	WP 22.1 Seminar Presentation of exemplary topics in theoretical physics	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

A total of 3 ECTS credits must be earned in the module. The attendance time is 2 semester hours per week. Including self-study, approximately 90 hours must be spent.

Module type	Compulsory elective module with compulsory course
Usabiltiy of the module in other programs	none
Elective guidlines	The module can be selected in accordance with the following rules: One compulsory elective module must be selected from the compulsory elective modules WP 21 and WP 22.
Entry requirements	none
Semester	Recommended semester: 6
Duration	The module extends over 1 semester.
Content	Students work on a topic from the field of theoretical physics, present it to the seminar group and discuss conclusions.
Learning outcomes	Students further develop their ability to work independently on a new topic from the field of theoretical physics using scientific literature. They deepen their skills in presenting scientific content in a structured and comprehensible manner.
Type of examination	Presentation
Type of assessment	The module is graded.
Requirements for awarding ECTS credits	ECTS credits will be granted when the module examination has been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft
Language(s)	German

Additional information none