Module Catalogue
for the Subject

Physics

as a Bachelor's with 1 major

with the degree "Bachelor of Science"

(180 ECTS credits)

Examination regulations version: 2015
Responsible: Faculty of Physics and Astronomy

Contents

Bachelor Thesis Physics 167

The subject is divided into

section / sub-section	ECTS credits	starting page
Compulsory Courses	129	10
Module Group Experimental Physics		11
Classical Physics	16	12
Optics and Quantum Physics I	6	19
Optics and Quantum Physics II	10	23
Structure of Matter	14	26
Module Group Theoretical Physics		31
Mechanics and Quantum Mechanics	16	32
Statistical Physics and Electrodynamics I	6	37
Statistical Physics and Electrodynamics II	10	40
Module Group Mathematics		43
Mathematics 1 and 2	16	44
Mathematics 3 and 4	16	47
Module Group Lab Course Physics		52
Laboratory Course Physics	19	53
Compulsory Electives	21	58
Module Group Chemistry, Computer Science, Mathematics		59
Module Group Applied Physics		92
Module Group Astrophysics		116
Module Group Particle Physics		120
Module Group Semiconductor Physics		126
Module Group Solid State and Nanostructure Physics		134
Module Group Current Topics in Physics		139
Key Skills Area	20	150
General Key Skills	5	151
General Key Skills (subject-specific)		152
Subject-specific Key Skills	15	159
Thesis	10	166

Learning Outcomes

German contents and learning outcome available but not translated yet.
Nach erfolgreichem Abschluss des Studiums verfügen die Absolventinnen und Absolventen über die folgenden Kompetenzen:

- Die Absolventinnen und Absolventen besitzen Abstraktionsvermögen, analytisches Denken, Problemlösungskompetenz und die Fähigkeit, komplexe Zusammenhänge zu strukturieren.
- Sie verstehen die Grundlagen und Zusammenhänge der Physik.
- Sie verfügen über Kenntnisse der mathematischen und theoretischen Grundlagen der Physik sowie über die theoretischen und experimentellen Methoden zur Erlangung neuer Erkenntnisse.
- Sie verfügen über ein breites Grundlagenwissen aus den wichtigsten Teilgebieten der Physik sowie tiefergehende Kenntnisse in mindestens einem Teilgebiet.
- Sie sind in der Lage, sich mit Hilfe von Fachliteratur in neue Aufgabengebiete einzuarbeiten, physikalische und mathematische Methoden unter Anleitung auf konkrete experimentelle oder theoretische physikalische Aufgabenstellungen anzuwenden, Lösungswege zu entwickeln und die Ergebnisse zu interpretieren und zu bewerten.
- Absolventinnen und Absolventen kennen die wissenschaftliche Arbeitsweise und sind in der Lage, physikalische Probleme unter Beachtung der Regeln guter wissenschaftlicher Praxis zu bearbeiten.
- Sie sind in der Lage, ihr Wissen und ihre Erkenntnisse einem Fachpublikum gegenüber darzustellen und zu vertreten.

Wissenschaftliche Befähigung

- Die Absolventinnen und Absolventen verstehen die mathematischen, theoretischen und experimentellen Grundlagen der Physik und können diese anwenden.
- Die Absolventinnen und Absolventen können unter Anleitung Experimente durchführen, analysieren und die erhaltenen Ergebnisse darstellen und bewerten.
- Die Absolventinnen und Absolventen setzen die erlernten theoretischen und experimentellen Methoden unter Anleitung zur Erlangung neuer Erkenntnisse ein.
- Die Absolventinnen und Absolventen sind in der Lage, physikalische Probleme durch Anwendung der wissenschaftlichen Arbeitsweise und unter Beachtung der Regeln guter wissenschaftlicher Praxis (Dokumentation, Fehleranalyse) zu bearbeiten.
- Die Absolventinnen und Absolventen können ihr Wissen und ihre Erkenntnisse einem Fachpublikum gegenüber darstellen und vertreten.
- Die Absolventinnen und Absolventen können ein breites Grundlagenwissen aus den wichtigsten Teilgebieten der Physik sowie tiefergehende Kenntnisse in mindestens einem Teilgebiet abrufen.
- Die Absolventinnen und Absolventen verstehen die wesentlichen Zusammenhänge und Konzepte der einzelnen Teilgebiete der Physik.
- Die Absolventinnen und Absolventen sind in der Lage, sich mit Hilfe von Fachliteratur in neue Aufgabengebiete einzuarbeiten, physikalische und mathematische Methoden unter Anleitung auf konkrete experimentelle oder theoretische physikalische Aufgabenstellungen anzuwenden, Lösungswege zu entwickeln und die Ergebnisse zu interpretieren und zu bewerten.
- Die Absolventinnen und Absolventen besitzen Abstraktionsvermögen, analytisches Denken, Problemlösungskompetenz und die Fähigkeit, komplexe Zusammenhänge zu strukturieren.

Befähigung zur Aufnahme einer Erwerbstätigkeit

- Die Absolventinnen und Absolventen können ihr Wissen und ihre Erkenntnisse einem Fachpublikum gegenüber darstellen und vertreten.

- Die Absolventinnen und Absolventen sind in der Lage, konstruktiv und zielorientiert in einem heterogenen Team zusammenzuarbeiten, unterschiedliche und abweichen-de Ansichten produktiv zur Zielerreichung zu nutzen und auftretende Konflikte zu lösen (Teamfähigkeit).
- Die Absolventinnen und Absolventen können ihre erworbenen Kompetenzen in unterschiedlichen interkulturellen Kontexten und in internationale zusammengesetzten Teams anwenden.
- Die Absolventinnen und Absolventen sind in der Lage, Probleme und deren Lösungen zielgruppengerecht und auch in einer Fremdsprache aufzubereiten und darzustellen.
- Die Absolventinnen und Absolventen sind in der Lage physikalische und mathematische Methoden unter Anleitung auf konkrete experimentelle oder theoretische physikalische Aufgabenstellungen anzuwenden, Lösungswege zu entwickeln und die Ergebnisse zu interpretieren und zu bewerten.
- Die Absolventinnen und Absolventen kennen die wichtigsten Anforderungen und Arbeitsweisen im industriellen Umfeld sowie in Forschung und Entwicklung.
- Die Absolventinnen und Absolventen sind befähigt, komplexere Probleme zu analysieren und zu lösen und sich sehr schnell auch in weniger vertraute Themenkomplexe einzuarbeiten.

Persönlichkeitsentwicklung

- Die Absolventinnen und Absolventen kennen die Regeln guter wissenschaftlicher Praxis und beachten sie.
- Die Absolventinnen und Absolventen können ihr Wissen und ihre Erkenntnisse einem Fachpublikum gegenüber darstellen und vertreten.

Befähigung zum gesellschaftlichen Engagement

- Die Absolventinnen und Absolventen können naturwissenschaftliche Entwicklungen kritisch reflektieren und deren Auswirkungen auf die Wirtschaft, Gesellschaft und die Umwelt in Ansätzen erfassen (Technikfolgenabschätzung).
- Die Absolventinnen und Absolventen haben ihr Wissen bezüglich wirtschaftlicher, gesellschaftlicher, naturwissenschaftlicher, kultureller etc. Fragestellungen erweitert und können begründet Position beziehen.
- Die Absolventinnen und Absolventen entwickeln die Bereitschaft und Fähigkeit, ihre Kompetenzen in partizipative Prozesse einzubringen und aktiv an Entscheidungen mitzuwirken.

Abbreviations used

Course types: **E** = field trip, **K** = colloquium, **O** = conversatorium, **P** = placement/lab course, **R** = project, **S** = seminar, **T** = tutorial, **Ü** = exercise, **V** = lecture

Term: **SS** = summer semester, **WS** = winter semester

Methods of grading: **NUM** = numerical grade, **B/NB** = (not) successfully completed

Regulations: **(L)ASPO** = general academic and examination regulations (for teaching-degree programmes), **FSB** = subject-specific provisions, **SFB** = list of modules

Other: **A** = thesis, **LV** = course(s), **PL** = assessment(s), **TN** = participants, **VL** = prerequisite(s)

Conventions

Unless otherwise stated, courses and assessments will be held in German, assessments will be offered every semester and modules are not creditable for bonus.

Notes

Should there be the option to choose between several methods of assessment, the lecturer will agree with the module coordinator on the method of assessment to be used in the current semester by two weeks after the start of the course at the latest and will communicate this in the customary manner.

Should the module comprise more than one graded assessment, all assessments will be equally weighted, unless otherwise stated below.

Should the assessment comprise several individual assessments, successful completion of the module will require successful completion of all individual assessments.

In accordance with

the general regulations governing the degree subject described in this module catalogue:

ASPO2015

associated official publications (FSB (subject-specific provisions)/SFB (list of modules)):

22-Jul-2015 (2015-40) except for mandatory elective 11-KDS-152 added in Fast Track procedure at a later time

14-Mar-2018 (2018-16)

12-Dec-2018 (2018-63)

12-Jun-2024 (2024-73)

This module handbook seeks to render, as accurately as possible, the data that is of statutory relevance according to the examination regulations of the degree subject. However, only the FSB (subject-specific provisions) and SFB (list of modules) in their officially published versions shall be legally binding.

In the case of doubt, the provisions on, in particular, module assessments specified in the FSB/SFB shall prevail.

Compulsory Courses

(129 ECTS credits)

Module Group Experimental Physics

(ECTS credits)

Classical Physics

(16 ECTS credits)

Module title	Abbreviation
Classical Physics 1 (Mechanics)	11-E-M-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: completion of exercises (approx. 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the semester.

Contents

1. Principles: Physical quantities, prefactors, derived quantities, dimensional analysis, time / length / mass (definition, measurement procedures, SI), importance of metrology;
2. Point Mechanics: Kinematics, motion in 2D and 3D / vectors, special cases: Uniform and constant accelerated motion, free fall, slate litter; circular motion in polar coordinates;
3. Newton's laws: Forces and momentum definition, weight vs. mass forces on the pendulum, forces on an atomic scale, isotropic and anisotropic friction. Preparation of the equations of motion and solutions;
4. Work and energy: (Kinetic) performance, examples;
5. Elastic, inelastic and super-elastic collision: Energy and momentum conservation, surges in centre of mass and balance system, rocket equation;
6. Conservative and non-conservative force fields: Potential, potential energy; law, weight scale, field strength and potential of gravity (general relations);
7. Rotational motion: Angular momentum, angular velocity, torque, rotational energy, moment of inertia, analogies to linear translation, applications, satellites (geostationary and interstellar), escape velocities, trajectories in the central potential;
8. Tidal forces: Inertial system, reference systems, apparent forces, Foucault pendulum, Coriolis force, centrifugal force;
9. Galilean transformation: Brief digression to Maxwell's equations, ether, Michelson interferometer, Einstein's postulates, problem of simultaneity, Lorentz transformation, time dilation and length contraction, relativistic impulse;
10. Rigid body and gyroscope: Determining the centre of mass, inertia tensor and -ellipsoid, principal axes and their stability, tensor on the example of the elasticity tensor, physics of the bike; gyroscope: Precession and nutation, the Earth as a spinning top;
11. Friction: Static and dynamic friction, stick-slip motion, rolling friction, viscous friction, laminar flow, eddy formation;
12. Vibration: Representation by means of complex e-function, equation of motion (DGL) on forces, torque and power approach, Taylor expansion, harmonic approximation; spring and pendulum, physical pendulum, damped vibration (resonant case, Kriechfall, aperiodic limit), forced vibration, Fourier analysis;
13. Coupled vibrations: Eigenvalues and eigenfunctions, double pendulum, deterministic vs. chaotic motion, non-linear dynamics and chaos;
14. Waves: Wave equation, transverse and longitudinal waves, polarisation, principle of superposition, reflection at the open and closed end, speed of sound; interference, Doppler effect; phase and group velocity, dispersion relation;
15. Elastic deformation of solid bodies: Elastic modulus, general Hooke's law, elastic waves;
16. Fluids: Hydrostatic pressure and buoyancy, surface tension and contact angle, capillary forces, steady flows, Bernoulli equation; Boyle-Mariotte, gas laws, barometric height formula, air pressure, compressibility and compressive modulus;
17. Kinetic theory of gases: ideal and real gas, averages, distribution functions, equipartition theorem, Brownian motion, collision cross section, mean free path, diffusion and osmosis, degrees of freedom, specific heat

Intended learning outcomes
The students understand the basic contexts and principles of mechanics, vibration, waves and kinetic theory of gases. They are able to apply mathematical methods to the formulation of physical contexts and autonomously apply their knowledge to the solution of mathematical-physical tasks.
Courses (type, number of weekly contact hours, language — if other than German)
V (4) + Ü (2) Module taught in: Ü: German or English
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 120 minutes) Language of assessment: German and/or English
Allocation of places
--
Additional information
Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's registration for assessment into effect. Only those students that meet the respective prerequisites can successfully register for an assessment. Students who did not register for an assessment or whose registration for an assessment was not put into effect will not be admitted to the respective assessment. If a student takes an assessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered.
Workload
240 h
Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 53 I Nr. 1 a) § 77 I Nr. 1 a)
Module appears in
Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Nanostructure Technology (2015) Bachelor's degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) First state examination for the teaching degree Grundschule Physics (2015) First state examination for the teaching degree Realschule Physics (2015) First state examination for the teaching degree Gymnasium Physics (2015) First state examination for the teaching degree Mittelschule Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2016) First state examination for the teaching degree Grundschule Physics (2018) First state examination for the teaching degree Realschule Physics (2018) First state examination for the teaching degree Gymnasium Physics (2018) First state examination for the teaching degree Mittelschule Physics (2018) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) First state examination for the teaching degree Grundschule Physics (2020) First state examination for the teaching degree Gymnasium Physics (2020) First state examination for the teaching degree Realschule Physics (2020)

First state examination for the teaching degree Mittelschule Physics (2020)
Bachelor's degree (1 major) Functional Materials (2021)
Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)
Bachelor's degree (1 major) Functional Materials (2025)

Module title	Abbreviation
Classical Physics 2 (Heat and Electromagnetism)	11-E-E-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: completion of exercises (approx. 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the semester.

Contents

1. Thermodynamics (linked to 11-E-M); temperature and quantity of heat, thermometer, Kelvin scale;
2. Heat conduction, heat transfer, diffusion, convection, radiant heat;
3. Fundamental theorems of thermodynamics, entropy, irreversibility, Maxwell's demon;
4. Heat engines, working diagrams, efficiency, example: Stirling engine;
5. Real gases and liquids, states of matter (also solids), van der Waals, critical point, phase transitions, critical phenomena (opalescence), coexistence region, Joule-Thomson;
6. Electrostatics, basic concepts: Electrical charge, forces; electric field, reps. field concept, field lines, field of a point charge;
7. Gaussian sentence, related to Coulomb's law, definition of "river"; Gaussian surface, divergence theorem; special symmetries; divergence and GS in differential form;
8. Electrical potential, working in the E-box, electric. potential, potential difference, voltage; potential equation, equipotential surfaces; several important examples: Sphere, hollow sphere, capacitor plates, electric dipole; lace effects, Segner wheel;
9. Matter in the E-field, charge in a homogeneous field, Millikan experiment, Braun tube; electron: Field emission, thermionic emission, dipole in homogeneous and inhomogeneous field; induction, Faraday cage;
10. Capacitor, mirror charge, definition, capacity; plate and spherical capacitor; combination of capacitors; media in the capacitor; electrical polarisation, displacement and orientation polarisation, microscopic image; dielectric displacement; electrolytic capacitor; Piezoelectric effect;
11. Electricity, introduction, current density, drift velocity, conduction mechanisms;
12. Resistance and conductivity, resistivity, temperature dependence; Ohm's law; realisations (resistive and non-ohmic, NTC, PTC);
13. Circuits, electrical networks, Kirchhoff's rules (meshes, nodes); internal resistance of a voltage source, measuring instruments; Wheatstone bridge;
14. Power and energy in the circuit; Capacitor charge; galvanic element; thermovoltage;
15. Transfer mechanisms, conduction in solids: Band model, semiconductor; line in liquids and gases;
16. Magnetostatics, fundamental laws; permanent magnet, field properties, definitions and units; Earth's magnetic field; Amper's Law, analogous to e-box, magn. river, swirl;
17. Vector potential, formal derivation, analogous to electric scalar potential; calculation of fields, examples, Helmholtz coils;
18. Moving charge in the static magnetic field, current balance, Lorentz force, right-hand rule, electric motor; dipole field; movement paths, mass spectrometer, Wien filters, Hall effect; electron: e / m determination;
19. matter in the magnetic field, effects of the field on matter, relative permeability, susceptibility; para-, dia-, ferromagnetism; magn. moment of the electron, behaviour at interfaces;
20. induction, Faraday's law of induction, Lenz's rule, flux change, eddy electric field, Waltenhofen's pendulum; inductance,self-induction; applications: Transformer, generator;
21. Maxwell's displacement current, choice of integration area, displacement current; Maxwell's extension, wave equation; Maxwell equations;
22. AC: Fundamentals, sinusoidal vibrations, amplitude, period and phase; power and RMS value, ohmic resistance; Capacitive & inductive resistor, capacitor and coil, phase shift and frequency dependence; impedance: Complex resistance; performance of the AC;

23. Resonant circuits, combinations of RLC; series and parallel resonant circuit; forced vibration, damped harmonic oscillator (related to 11-E-M);
24: Hertz dipole, characteristics of irradiation, near field, far field; Rayleigh scattering; accelerated charge, synchrotron radiation, X-rays; 25. Electromagnetic waves: Principles, Maxwell's determination to electromagnetism, radiation pressure (Poynting vector, radiation pressure).

Intended learning outcomes

The students understand the basic principles and contexts of thermodynamics, science of electricity and magnetism. They know relevant experiments to observe and measure these principles and contexts. They are able to apply mathematical methods to the formulation of physical contexts and autonomously apply their knowledge to the solution of mathematical-physical tasks.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's registration for assessment into effect. Only those students that meet the respective prerequisites can successfully register for an assessment. Students who did not register for an assessment or whose registration for an assessment was not put into effect will not be admitted to the respective assessment. If a student takes an assessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered.

Workload

240 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 53 I Nr. 1 a)
§ 77 I Nr. 1 a)

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)
First state examination for the teaching degree Grundschule Physics (2015)
First state examination for the teaching degree Realschule Physics (2015)
First state examination for the teaching degree Gymnasium Physics (2015)
First state examination for the teaching degree Mittelschule Physics (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
First state examination for the teaching degree Grundschule Physics (2018)
First state examination for the teaching degree Realschule Physics (2018)
First state examination for the teaching degree Gymnasium Physics (2018)
First state examination for the teaching degree Mittelschule Physics (2018)
Bachelor's degree (1 major) Physics (2020)

Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020)
First state examination for the teaching degree Grundschule Physics (2020)
First state examination for the teaching degree Gymnasium Physics (2020)
First state examination for the teaching degree Realschule Physics (2020)
First state examination for the teaching degree Mittelschule Physics (2020)
Bachelor's degree (1 major) Functional Materials (2021)
Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)
Bachelor's degree (1 major) Functional Materials (2025)

Optics and Quantum Physics I

(6 ECTS credits)

Module title				Abbreviation
Optics and Quantum Physics				11-E-OAV-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
2 semester	undergraduate	--		

Contents

A. optics and quanta

1. Light (linked to 11-E-E): basic concepts, the speed of light, Huygens-Fresnel principle: reflection, refraction.
2. Light in matter: propagation velocity in the medium; dispersion, complex and frequency-dependent dielectric constant; absorption, Kramers-Kronig relation, interfaces, Fresnel equations, polarization, generation by absorption, birefringence, optical activity (dipole)
3. Geometrical optics: basic concepts, Fermat's principle, optical path, planar interfaces, Snell's law, total reflection, optical tunneling, evanescent waves, prism; normal and anomalous dispersion, curved interfaces, thin and thick lenses, lens systems, lens grinder formula, aberrations, imaging errors (spherical & chromatic aberration, astigmatism, coma, distortion, correction approaches).
4. Optical instruments: characteristics; camera, eye, magnifying glass, microscope, telescope types, bundle beam vs. image construction (electron lenses, electron microscope), confocal microscopy.
5. Wave optics: spatial and temporal coherence, Young's double slit experiment, interference pattern (intensity profile), thin films, parallel layers, wedge-shaped layers, phase shift, Newton rings, interferometer (Michelson, Mach-Zender, Fabry-Perot).
6. Diffraction in the far field: Fraunhofer diffraction, , single slit, intensity distribution, apertures, resolving power, Rayleigh & Abbé criterion, Fourier optics, optical grating, n-fold slit, intensity distribution, grating spectrometer and resolution, diffraction off atomic lattices, convolution theorem.
7. Diffraction in the near field: Fresnel, near-field diffraction at circular apertures/disks, Fresnel zone plate, near-field microscopy, holography, Huygens-Fresnel concept; white light hologram.
8. Failure of classical physics I - from light wave to photon: black body radiation and Planck's quantum hypothesis; photoelectric effect and Einstein's explanation, Compton effect, light as a particle, wave-particle duality, , quantum structure of nature
9. Failure of classical physics II - particles as waves: de Broglie's matter wave concept; diffraction of particle waves (Davisson-Germer-experiment, double slit interference).
10. Wave mechanics: wave packets, phase and group velocity (recap of 11-EM), uncertainty principle, Nyquist-Shannon theorem, wave function as probability amplitude, probability of residence, measurement process in quantum mechanics (double-slit experiment & which-way information, collapse of the wave function, Schrödinger's cat).
11. Mathematical concepts of quantum mechanics: Schrödinger equation as wave equation, conceptual comparison to wave optics, free particle and particles in a potential, time-independent Schrödinger equation as eigenvalue equation, simple examples in 1D (potential step, potential barrier and tunnel effect, box potential and energy quantization, harmonic oscillator), box potential in higher dimensions and degeneracy, formal theory of QM (states, operators, observables).

B. atomic and molecular physics

1. Structure of atoms: experimental evidence for the existence of atoms, size of the atom, charges and masses in the atom, isotopes, internal structure, Rutherford experiment, instability of the "classical" Rutherford atom
2. Quantum mechanical foundations of atomic physics (short recap of part A.): light as particle beam, particles as waves, wave functions and probability interpretation, uncertainty relation and stability of the atom, energy quantization in the atom, Franck-Hertz experiment, atomic spectra, Bohr's model and its limitations, non-relativistic Schrödinger equation.

3. The non-relativistic hydrogen atom: hydrogen and hydrogen-like atoms, central-symmetric potential and angular momentum in QM, Schrödinger equation of the H-atom, atomic orbitals, radial and angular wave functions, quantum numbers, energy eigenvalues.
4.Atoms in external fields: orbital magnetic dipole moment, gyromagnetic ratio, magentic fields: normal Zeeman effect, electrical fields: Stark effect.
5. Fine and hyperfine structure: electronic spin and magnetic spin moment, Stern-Gerlach experiment, Einstein-de Haas effect, glimpse of the Dirac equation (spin as relativistic phenomenon and existence of antimatter), electron spin resonance (ESR), spin-orbit coupling, relativistic fine structure, Lamb shift (quantum electrodynamics), nuclear spin and hyperfine structure.
6. Multielectron atoms: helium atom as simplest example, indistinguishability of identical particles, (anti)symmetry with respect to particle exchange, fermions and bosons, relationship to spin, Pauli principle, orbital and spin wave function of two-particle systems (spin singlets and triplets), LS- and jj-coupling, periodic table of the elements, Aufbau principles and Hund's rules.
7. Light-matter interaction: time-dependent perturbation theory (Fermi's Golden Rule) and optical transitions, matrix elements and dipole approximation, selection rules and symmetry, line broadening (lifetime, Doppler effect, collision broadening), atomic spectroscopy.
8. LASER: elementary optical processes (absorption, spontaneous and stimulated emission), stimulated emission as light amplification, Einstein's rate equations, thermal equilibrium, non-equilibrium character of a laser: rate equations, population inversion, and laser condition, principle structure of a laser, optical pumping, 2-, 3- and 4-level lasers, examples (ruby laser, He-Ne laser, semiconductor laser).
9. Inner-shell excitations and x-ray physics: generation of x-ray radiation, Bremsstrahlung and characteristic spectrum, x-ray emission for elemental analysis (EDX), x-ray absorption and contrast formation in x-ray images, x-ray photoemission, non-radiative Auger processes, synchrotron radiation, application examples.
10. Molecules and chemical bonding: molecular hydrogen ion (H_2^+) as simplest example: rigid molecule approximation and LCAO approach, bonding and antibonding molecular orbitals, hydrogen molecule (H_2): molecular orbital vs. Heitler-London approximation, biatomic heteronuclear molecules: covalent vs. ionic bonding, van der Waals bonds and Lennard-Jones potential, (time allowing: conjugated molecules).
11. Molecule rotations and vibrations: Born-Oppenheimer approximation, rigid rotator (symmetric and unsymmetrical molecules), centrifugal splitting/expansion, molecule as (an)harmonic oscillator, Morse potential, normal vibrational modes, vibrational-rotational interaction.
12. Molecular spectroscopy: transition matrix elements, vibrational spectroscopy: infrared spectroscopy and Raman effect, vibrational-rotational transitions: Fortrat diagram, electronic transitions: Franck-Condon principle.

Intended learning outcomes

The students understand the basic principles and contexts of radiation, wave and quantum optics and quantum phenomena as well as Atomic and Molecular Physics. They understand the theoretical concepts and know the structure and application of important optical instruments and measuring methods. They understand the ideas and concepts of quantum theory and Astrophysics and the relevant experiments to observe and measure quantum phenomena. They are able to discuss their knowledge and to integrate it into a bigger picture.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + V (4)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

oral examination of one candidate each (approx. 30 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)	
--	
Module appears in	
Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Nanostructure Technology (2015) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Quantum Technology (2021) exchange program Physics (2023)	

Optics and Quantum Physics II

(10 ECTS credits)

Module title				**Abbreviation**
Optics and Waves - Exercises				11-E-OA-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
5	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Exercises in Optics accordingto the content of 11-E-OAV. Among others Basic concepts, Fermat's principle, optical path, light in matter, polarization, Geometrical Optics, Optical instruments, wave optics, interference, thin films, interferometers, Fraunhofer diffraction optical grating, Fresnel diffraction, holography, wave packets, wave equation and Schrödinger equation, quantum structure of nature, etc.

Intended learning outcomes

The students understand the basic principles and contexts of radiation, wave and quantum optics. They are able to apply mathematical methods to the formulation of physical contexts and autonomously apply their knowledge to the solution of mathematical-physical tasks.

Courses (type, number of weekly contact hours, language — if other than German)

Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 53 I Nr. 1 a)
§ 77 I Nr. 1 a)

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
First state examination for the teaching degree Grundschule Physics (2015)
First state examination for the teaching degree Realschule Physics (2015)
First state examination for the teaching degree Gymnasium Physics (2015)
First state examination for the teaching degree Mittelschule Physics (2015)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)

Module title				Abbreviation
Atoms and Quanta - Exercises				11-E-AA-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

Exercises in Atomic and Quantum Physics according to the contents of 11-E-OAV. Among others Structure of atoms, experimental fundamental laws of Quantum Physics, the Schrödinger equation, quantum mechanics of the hydrogen atom, atoms in external fields, multi-electron atoms, optical transitions and spectroscopy, laser, molecules and chemical bonding, molecular rotations and vibrations, etc.

Intended learning outcomes

The students understand the basic principles and contexts of quantum phenomena as well as Atomic and Molecular Physics. They are able to mathematically formulate physical contexts of Atomic and Quantum Physics and to autonomously apply their knowledge to the solution of mathematical-physical tasks.

Courses (type, number of weekly contact hours, language — if other than German)

Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)

Structure of Matter

(14 ECTS credits)

Module title				**Abbreviation**
Introduction to Solid State Physics				11-E-F-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
8	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

1. The free-electron gas (FEG), free electrons; density of states; Pauli principle; Fermi-Dirac statistics; spec. heat, Sommerfeld coefficient; electrons in fields: Drude-Lorentz-Sommerfeld; electrical and thermal conductivity, Wiedemann-Franz law; Hall effect; limitations of the model
2. Crystal structure, periodic lattice; types of lattices; Bravais lattice; Miller indices; simple crystal structures; lattice defects; polycrystals; amorphous solids; group theoretical approaches, the importance of symmetry for electronic properties
3. The reciprocal lattice (RG), motivation: Diffraction; Bragg condition; definition; Brillouin zones; diffraction theory: Scattering; Ewald construction; Bragg equation; Laue's equation; structure and form factor
4. Structure determination, probes: X-ray, electron, neutron; methods: Laue, Debye-Scherrer, rotating crystal; electron diffraction, LEED
5. lattice vibrations (phonons), equations of motion; dispersion; group velocity; diatomic base: optical, acoustic branch; quantisation: Phonon momentum; optical properties in the infrared; dielectric function (Lorentz model); examples of dispersion curves (occ. Kramers-Kronig), measurement methods
6. Thermal properties of insulators, Einstein and Debye model; phonon density of states; anharmonicity and thermal expansion; thermal conductivity; Umklapp processes; crystal defects
7. Electrons in a periodic potential, Bloch theorem; band structure; approximation of nearly free electrons (NFE); strongly bound electrons (tight binding, LCAO); examples of band structures, Fermi surfaces, spin-orbit interaction
8. Superconductivity, BCS theory, pairing, coupling of bosonic and fermionic modes, band structure, many-particle aspects (quasiparticle concept)

Intended learning outcomes

The students understand the basic contexts and principles of Solid-State Physics (bonding and structure, lattice dynamics, thermal properties, principles of electronic properties (free electron gas)). They understand the structure of solids and know the experimental methods and theoretical models for the description of phenomena of Solid-State Physics. They are able to apply mathematical methods to the formulation of physical contexts and autonomously apply their knowledge to the solution of mathematical-physical tasks.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

240 h

Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module appears in
Bachelor's degree (1 major) Mathematics (2015) Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Nanostructure Technology (2015) Bachelor's degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major) Computational Mathematics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor's degree (1 major) Mathematical Physics (2016) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor's degree (1 major) Quantum Technology (2021) Bachelor's degree (1 major) Mathematics (2023) exchange program Physics (2023) Bachelor's degree (1 major) Mathematical Physics (2024)

Module title				**Abbreviation**
Nuclear and Elementary Particle Physics				11-E-T-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
6	numerical grade		--	
Duration	**Module level**		**Other prerequisites**	
1 semester	undergraduate		--	

Contents

1. Overview, historical introduction, history and significance of Nuclear and Particle Physics
2. Methods of Nuclear Physics, scattering and spectroscopy, nuclear radius, composition of matter, mass and charge distribution in the nucleus, the discovery of the proton and neutron
3. Nuclear models, the mass of the atomic nuclei, droplet model, bonding energy, nuclear shell model
4. Structure of cores, angular momentum, spin, parity, mag. and electr. moments, collective excitation forms, spin-orbit interaction
5. Radioactivity and spectroscopy, radioactive decay, natural and civilisational sources of ionising radiation
6. Nuclear energy, nuclear fission, nuclear reactors, nuclear fusion, star power, star development, formation of the chemical elements of hydrogen
7. Radiation and matter, interaction of radiation and matter, Bethe-Bloch formula, photoelectric effect, pair production
8. Instruments, accelerators and detectors
9. Electromagnetic interaction, differential cross section, virtual photons, Feynman graphs, exchange interaction
10. Strong interaction, quarks, gluons, colour and degree of freedom, deep-inelastic electron-proton scattering, confinement, asymptotic freedom, particle zoo, isospin, strangeness, SU (3) symmetry, antiprotons
11. Weak interaction, cracked mirror symmetries, Wu experiment, charge conjugation, time reversal, CP invariance, exchange particles, W and Z, neutrinos, neutrino vibrations
12. Standard model, three families of leptons and quarks, quark-lepton symmetry, Higgs boson, free parameters

Intended learning outcomes

The students understand the basic connections between fundamental Nuclear and Elementary Particle Physics. They have an overview of the experimental observations of Particle Physics and the theoretical models which describe them.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + Ü (1)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in
Bachelor's degree (1 major) Mathematics (2015) Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major) Computational Mathematics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor's degree (1 major) Mathematical Physics (2016) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor's degree (1 major) Mathematics (2023) exchange program Physics (2023) Bachelor's degree (1 major) Mathematical Physics (2024)

Module Group Theoretical Physics

(ECTS credits)

Mechanics and Quantum Mechanics

(16 ECTS credits)

Module title				Abbreviation
Theoretical Mechanics				11-T-M-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
8	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	Admission prerequisite to assessment: completion of exercises (approx. 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the semester.		

Contents

1. Newton's formulation: Inertial systems, Newton's laws of motion, equations of motion; one-dimensional motion, energy conservation; Harmonic oscillator; Movement in space of intuition, conservative forces;
2. Lagrangian formulation: Variational principles, Euler-Lagrange equation; constraints; coordinate transformations, mechanical gauge transformation; symmetries, Noether theorem, cyclic coordinates; accelerated reference systems and apparent forces;
3. Hamiltonian formulation: Legendre transformation, phase space; Hamilton function, canonical equations; Poisson brackets, canonical transformations; generator of symmetries, conservation laws; minimal coupling; Liouville theorem; Hamilton-Jacobi formulation [optional];
4. Applications: Central-force problems; mechanical similarity, Virial theorem; minor vibrations; particles in an electromagnetic field; rigid bodies, torque and inertia tensor, centrifugal and Euler equations [optional]; scattering, cross section [optional];
5. Relativistic dynamics: Lorentz Transformation; Minkowski space; equations of motion; 6. Non-linear dynamics: Stability theory; KAM theory [optional]; deterministic chaos [optional]

Intended learning outcomes

The students have gained first experiences concerning the working methods of Theoretical Physics. They are familiar with the principles of theoretical mechanics and their different formulations. They are able to independently apply the acquired mathematical methods and techniques to simple problems of Theoretical Physics and to interpret the results. They have especially acquired knowledge of basic mathematical concepts.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's registration for assessment into effect. Only those students that meet the respective prerequisites can successfully register for an assessment. Students who did not register for an assessment or whose registration for an assessment was not put into effect will not be admitted to the respective assessment. If a student takes an assessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered.

Workload
240 h
Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module appears in
Bachelor's degree (1 major) Mathematics (2015) Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Nanostructure Technology (2015) Bachelor's degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major) Computational Mathematics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor's degree (1 major) Quantum Technology (2021) Bachelor's degree (1 major) Mathematics (2023) exchange program Physics (2023) Bachelor's degree (1 major) Mathematical Physics (2024)

Module title	Abbreviation
Quantum Mechanics	11-T-Q-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: completion of exercises (approx. 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the semester.

Contents

1. History and basics: Limits of classical physics; fundamental historical experiments; from classical physics to quantum mechanics (QM);
2. Wave function and Schrödinger equation (SG): SG for free particles; superposition; probability distribution for pulse measurement; correspondence principles: postulates of QM; Ehrenfest theorem; continuity equation; stationary solutions of SG
3. Formalisation of QM: Eigenvalue equations; Physical significance of the eigenvalues of an operator; state space and Dirac notation; representations in state space; tensor products of state spaces;
4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy-time uncertainty;
5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symmetry properties;
6. Spin-1/2 systems I: Theoretical description in Dirac notation; Spin 1/2 in the homogeneous magnetic field; two-level systems (qubits);
7. Angular momentum: Commutation and rotations; eigenvalues of the angular momentum operators (abstract); solution of the eigenvalue equation in polar coordinates (concrete);
8. Central potential - hydrogen atom: Bonding states in 3D; Coulomb potential;
9. Motion in an electromagnetic field: Hamiltonian; Normal Zeeman effect; canonical and kinetic momentum; Gauge transformation; Aharonov-Bohm effect; Schrödinger, Heisenberg and interaction representation; motion of a free electron in a magnetic field;
10. Spin-1/2 systems II: Formulation using angular momentum algebra;
11. Addition of angular momenta:
12. Approximation methods: Stationary perturbation theory (with examples); variational method; WKB method; time-dependent perturbation theory;
13. Atoms with several electrons: Identical particles; Helium atom; Hartree and Hartree-Fock approximation; atomic structure and Hund's rules

Intended learning outcomes

The students have gained first experiences concerning the working methods of Theoretical Physics. They are familiar with the principles of quantum theory. They are able to apply the acquired mathematical methods and techniques to simple problems of quantum theory and to interpret the results. They have especially acquired knowledge of advanced mathematical concepts.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places
--
Additional information
Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's registration for assessment into effect. Only those students that meet the respective prerequisites can successfully register for an assessment. Students who did not register for an assessment or whose registration for an assessment was not put into effect will not be admitted to the respective assessment. If a student takes an assessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered.
Workload
240 h
Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module appears in
Bachelor's degree (1 major) Mathematics (2015) Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major) Computational Mathematics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor's degree (1 major) Mathematics (2023) exchange program Physics (2023) Bachelor's degree (1 major) Mathematical Physics (2024)

Statistical Physics and Electrodynamics I

(6 ECTS credits)

Module title	Abbreviation
Statistical Physics and Electrodynamics	11-T-SE-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--

Duration	Module level	Other prerequisites
2 semester	undergraduate	--

Contents

A. Statistical Physics;
0. Principles of statistics: Elements of statistics (central limit theorem and statistics of extremes); Micro- and macro-states; probability space (conditional probability, statistical independence);
1. Statistical Physics: Entropy and probability theory; entropy in classical physics; thermodynamic equilibrium in closed and open systems (with energy and / or particle exchange);
2. Ideal systems: Spin systems; linear oscillators; ideal gas;
3. Statistical Physics and thermodynamics: The 1st law; quasi-static processes; entropy and temperature; generalised forces; the second and third law; reversibility; transition from Statistical Physics to thermodynamics;
4. Thermodynamics: Thermodynamic fundamentals relationship; thermodynamic potentials; changes of state; thermodynamic machines (Carnot engine and efficiency); chemical potential;
5. Ideal Systems II, quantum statistics: Systems of identical particles; ideal Fermi gas; ideal Bose gas and Bose-Einstein condensation; grids and normal modes: Phonons;
6. Systems of interacting particles: Approximation methods (mean-field theory, Sommerfeld expansion); computer simulation (Monte Carlo method); interacting phonons (Debye approximation); Ising models (particularities in 1 and 2 dimensions); Yang-Lee-theorems; Van der Waals equation for real interacting gases;
7. Critical phenomena: Scaling laws, critical slowing down, fast variable as Bad (electron-phonon interaction and BCS superconductivity); magnetism (quantum criticality at low temperatures, quantum phase transitions at T = 0); problems of the thermodynamic limit;

B. Electrodynamics;
0. Mathematical tools: Gradient, divergence, curl; curve, surface, volume integrals; Stokes and Gaussian sentence; Delta function; Fourier transform; full functional systems; solving PDEs;
1. Maxwell equations;
2. Electrostatics: Coulomb's law; electrostatic potential; charged interface; electrostatic field energy (capacitor); multipole expansion; Boundary value problems; numerical solution; Image charges; Green's functions; development according to orthogonal functions;
3. Magnetostatics: Current density; continuity equation; vector potential; Biot-Savart law; magnetic moment; analogies to electrostatics;
4. Maxwell equations in matter: Electrical and magnetic susceptibility; interfaces;
5. Dynamics of electromagnetic fields: Faraday induction; RCL-circuits; field energy and pulse; potentials; plane waves; wave packets; plane waves in matter; cavity resonators and wave guides; inhomogeneous wave equation; temporally oscillating sources and dipole radiation; accelerated point charges;
6. Special Theory of Relativity: Lorentz transform; simultaneity; length contraction and time dilation; light cone; effect, energy and momentum; co- and contra-variant tensors; covariant classical mechanics;
7. Covariant electrodynamics: Field strength tensor and Maxwell's equations; transformation of the fields; Doppler effect; Lorentz force

Intended learning outcomes

The students have advanced knowledge of the methods of Theoretical Physics. They know the principles of electrodynamics, thermodynamics and statistical mechanics. They are able to discuss the acquired theoretical concepts and to attribute them to bigger physical contexts.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + V (4)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
oral examination of one candidate each (approx. 30 minutes) Language of assessment: German and/or English
Allocation of places
--
Additional information
--
Workload
180 h
Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module appears in
Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2016) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Mathematical Physics (2020) exchange program Physics (2023) Bachelor's degree (1 major) Mathematical Physics (2024)

Statistical Physics and Electrodynamics II

(10 ECTS credits)

Module title				Abbreviation
Statistical Physics - Exercises				11-T-SA-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
5	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Exercises in Statistical Physics and theoretical thermodynamics according to the content of 11 T-SEV content. Among others Principles of statistics, Statistical Physics, ideal systems, fundamental theorems, thermodynamic potentials, quantum statistics, Fermi and Bose gas, systems of interacting particles, approximation methods, Ising models, critical phenomena, etc.

Intended learning outcomes

The students are familiar with the mathematical methods of theoretical thermodynamics and Statistical Physics and are able to independently apply them to the description and solution of problems of Statistical Physics and to interpret the results in a physical manner.

Courses (type, number of weekly contact hours, language — if other than German)

Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)

Module title				Abbreviation
Electrodynamics - Exercises				11-T-EA-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
5	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Exercises in electrodynamics according to the content of 11 T-SEV. Among others Mathematical tools, Maxwell's equations, electrostatics, magnetostatics, Maxwell equations in matter, dynamic electromagnetic fields, electromagnetic waves, special relativity, covariant electrodynamics etc.

Intended learning outcomes

The students are familiar with the mathematical methods of theoretical electrodynamics and are able to independently apply them to the description and solution of problems of electrodynamics and to interpret the results in a physical manner.

Courses (type, number of weekly contact hours, language — if other than German)

Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
exchange program Physics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)

Module Group Mathematics

(ECTS credits)

Mathematics 1 and 2

(16 ECTS credits)

<table>
<tr><td colspan="4">Module title</td><td>Abbreviation</td></tr>
<tr><td colspan="4">Mathematics 1 for Students of Physics and Nanostructure Technology</td><td>10-M-PHY1-152-m01</td></tr>
<tr><td colspan="3">Module coordinator</td><td colspan="2">Module offered by</td></tr>
<tr><td colspan="3">Dean of Studies Mathematik (Mathematics)</td><td colspan="2">Institute of Mathematics</td></tr>
<tr><td>ECTS</td><td>Method of grading</td><td colspan="3">Only after succ. compl. of module(s)</td></tr>
<tr><td>8</td><td>numerical grade</td><td colspan="3">--</td></tr>
<tr><td>Duration</td><td>Module level</td><td colspan="3">Other prerequisites</td></tr>
<tr><td>1 semester</td><td>undergraduate</td><td colspan="3">--</td></tr>
<tr><td colspan="5">Contents</td></tr>
<tr><td colspan="5">Fundamentals on numbers and functions, sequences and series, differential and integral calculus in one variable, vector spaces, simple differential equations.</td></tr>
<tr><td colspan="5">Intended learning outcomes</td></tr>
<tr><td colspan="5">The student gets acquainted with basic concepts of mathematics. He/She learns to apply these methods to simple problems in natural and engineering sciences, in particular in the fields of physics and nanostructure technology, and is able to interpret the results.</td></tr>
<tr><td colspan="5">Courses (type, number of weekly contact hours, language — if other than German)</td></tr>
<tr><td colspan="5">V (5) + Ü (2)
Module taught in: Ü: German or English</td></tr>
<tr><td colspan="5">Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)</td></tr>
<tr><td colspan="5">a) written examination (approx. 90 to 120 minutes, usually chosen) or
b) oral examination of one candidate each (approx. 20 minutes) or
c) oral examination in groups (groups of 2, 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus</td></tr>
<tr><td colspan="5">Allocation of places</td></tr>
<tr><td colspan="5">--</td></tr>
<tr><td colspan="5">Additional information</td></tr>
<tr><td colspan="5">--</td></tr>
<tr><td colspan="5">Workload</td></tr>
<tr><td colspan="5">240 h</td></tr>
<tr><td colspan="5">Teaching cycle</td></tr>
<tr><td colspan="5">--</td></tr>
<tr><td colspan="5">Referred to in LPO I (examination regulations for teaching-degree programmes)</td></tr>
<tr><td colspan="5">--</td></tr>
<tr><td colspan="5">Module appears in</td></tr>
<tr><td colspan="5">Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)</td></tr>
</table>

Module title				Abbreviation
Mathematics 2 for Students of Physics and Nanostructure Technology				10-M-PHY2-152-m01
Module coordinator			**Module offered by**	
Dean of Studies Mathematik (Mathematics)			Institute of Mathematics	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
8	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Linear maps and systems of linear equations, matrix calculus, eigenvalue theory, differential and integral calculus in several variables, differential equations, Fourier analysis.

Intended learning outcomes

The student gets acquainted with fundamental concepts of advanced mathematics. He/She learns to apply these methods to simple problems in natural and engineering sciences, in particular in the field of physics and nanostructure technology, and is able to interpret the results.

Courses (type, number of weekly contact hours, language — if other than German)

V (5) + Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes, usually chosen) or
b) oral examination of one candidate each (approx. 20 minutes) or
c) oral examination in groups (groups of 2, 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

240 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)

Mathematics 3 and 4

(16 ECTS credits)

Module title				Abbreviation
Mathematics 3 for Students of Physics and related Disciplines (Differential Equations)				11-M-D-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
8	numerical grade		--	
Duration	**Module level**		**Other prerequisites**	
1 semester	undergraduate		--	

Contents

Basics of ordinary differential equations in physics.
Ordinary differential equations and systems of differential equations.
Fundamentals of function theory.

1. Ordinary differential equations
1.1 Solution methods
1.2 Existence and uniqueness theorem
1.3 Systems of differential equations
1.4 Greens function for inhomogeneous problems
1.5 Hermitsche DGL, Legendre DGL

2. Function theory
2.1 Complex functions
2.2 Differentiation, holomorphic functions
2.3 Singularities in the complex
2.4 Complex integration and the Cauchy integral theorem
2.5 Laurent series, residual theorem, Fourier transformation
2.6 Analytical continuation, meromorphic functions, whole functions
2.7 gamma, beta, hypergeometric functions, sets of Weierstrasse and Mittag-Leffler
2.8 Differential equations in the complex, Bessel differential equation
2.9 Saddle point method

3. (quasi) linear differential equations of 1st order

Intended learning outcomes

The student has basic knowledge of mathematics to understand the dynamic equations and knowledge of solution methods for ordinary differential equations as well as the theory of the functions of a complex variable and is proficient in the required computing techniques.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload
240 h
Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module appears in
Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Nanostructure Technology (2015) Bachelor's degree (1 major) Functional Materials (2015) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Functional Materials (2021) Bachelor's degree (1 major) Quantum Technology (2021) exchange program Physics (2023) Bachelor's degree (1 major) Functional Materials (2025)

Module title				Abbreviation
Mathematics 4 for Students of Physics and related Disciplines (Complex Analysis)				11-M-F-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	

ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

Basic knowledge of functional analysis that is required in the course Quantum Mechanics I. The definition of Hilbert space opens up understanding of quantum mechanical states as vectors. The representation-free form of quantum mechanics and the representation as a wave function generated by basic states form an important element of the formal framework of quantum mechanics with the so-called bracket formalism by Dirac.
Fundamentals of partial differential equations in physics and systems of differential equations.

Part I: functional analysis
1.1 Linear vector spaces
1.2 Metric, standardized spaces
1.3 Linear operators
1.4 Function space, completion, Lebesgue integral, Hilbert space
1.5 Linear operators on the Hilbert space
1.6 Matrix representation of operators
1.8 The Dirac delta function and its different representations

Part II: differential equations
2. Partial differential equations
2.1 Linear partial differential equations of 2nd order
2.2 1D and 3D wave equation
2.3 Helmholtz equation and potential theory
2.4 Parabolic differential equations

Intended learning outcomes

The student has basic knowledge of mathematics and basic knowledge of Hilbert space mathematics, as well as knowledge of solution methods for partial differential equations and is proficient in the necessary computing techniques.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

240 h

Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module appears in
Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Nanostructure Technology (2015) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Functional Materials (2021) Bachelor's degree (1 major) Quantum Technology (2021) exchange program Physics (2023) Bachelor's degree (1 major) Functional Materials (2025)

Module Group Lab Course Physics

(ECTS credits)

Laboratory Course Physics

(19 ECTS credits)

Module title			Abbreviation
Laboratory Course Physics A (Mechanics, Heat, Electromagnetism)			11-P-PA-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
3	(not) successfully completed	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

Measurement tasks in mechanics, thermodynamics and electricity theory, e.g. measurement of voltages and currents, heat capacity, calorimetry, density of bodies, dynamic viscosity, elasticity, surface tension, spring constant, drafting of graphics and drafting of measurement protocols.

Intended learning outcomes

The students know and have mastered physical measuring methods and experimenting techniques. They are able to independently plan and conduct experiments, to cooperate with others, and to document the results in a measuring protocol.

Courses (type, number of weekly contact hours, language — if other than German)

P (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

practical assignment with talk (approx. 30 minutes)
Preparing, performing and evaluating (record of readings or lab report) the experiments will be considered successfully completed if a Testat (exam) is passed. Exactly one experiment that was not successfully completed can be repeated once. After completion of all experiments, talk (with discussion; approx. 30 minutes) to test the candidate's understanding of the physics-related contents of the module. Talks that were not successfully completed can be repeated once. Both components of the assessment have to be successfully completed.

Allocation of places

--

Additional information

--

Workload

90 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Mathematics (2015)
Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major) Computational Mathematics (2015)
Bachelor's degree (1 major) Aerospace Computer Science (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major) Aerospace Computer Science (2017)
Bachelor's degree (1 major) Physics (2020)

Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major) Aerospace Computer Science (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
Bachelor's degree (1 major) Mathematics (2023)
exchange program Physics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)

Module title				Abbreviation
Laboratory Course Physics B (Classical Physics, Electricity, Circuits)				11-P-PB-152-m01

Module coordinator	**Module offered by**
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	**Method of grading**	**Only after succ. compl. of module(s)**
8	(not) successfully completed	--

Duration	**Module level**	**Other prerequisites**
2 semester	undergraduate	Students are highly recommended to complete modules 11-P-PA and 11-P-FR1 prior to completing module 11-P-PB.

Contents

Physical laws of optics, vibrations and waves, science of electricity and circuits with electric components.

Intended learning outcomes

The students know and have mastered physical measuring methods and experimenting techniques. They are able to independently plan and conduct experiments, to cooperate with others, and to document the results in a measuring protocol. They are able to evaluate the measuring results on the basis of error propagation and of the principles of statistics and to draw, present and discuss the conclusions.

Courses (type, number of weekly contact hours, language — if other than German)

P (2) + P (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

practical assignment with talk (approx. 30 minutes)
Preparing, performing and evaluating (record of readings or lab report) the experiments will be considered successfully completed if a Testat (exam) is passed. Exactly one experiment that was not successfully completed can be repeated once. After completion of all experiments, talk (with discussion; approx. 30 minutes) to test the candidate's understanding of the physics-related contents of the module. Talks that were not successfully completed can be repeated once. Both components of the assessment have to be successfully completed.

Allocation of places

--

Additional information

--

Workload

240 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Physics (2020)
exchange program Physics (2023)

Module title				Abbreviation
Advanced Laboratory Course Physics C (Modern Physics, Computer Aided Experiments)				11-P-PC-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
8	(not) successfully completed	--		
Duration	**Module level**	**Other prerequisites**		
2 semester	undergraduate	Students are highly recommended to complete module 11-P-PB prior to completing module 11-P-PC.		

Contents
Physical laws of wave optics, Molecular, Atomic and Nuclear Physics and modern measuring methods using special computerised devices with examples from optics and Solid-State Physics.
Intended learning outcomes
The students are able to build and almost independently operate advanced experimental setups. They are able to record measuring results in a structured manner, even in case of huge data traffic, and to analyse the results by using error propagation and statistics. They are able to evaluate results, to draw conclusions and to present and discuss them in a scientific paper and a presentation.
Courses (type, number of weekly contact hours, language — if other than German)
P (2) + P (2)
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
practical assignment with talk (approx. 30 minutes) Preparing, performing and evaluating (record of readings or lab report) the experiments will be considered successfully completed if a Testat (exam) is passed. Exactly one experiment that was not successfully completed can be repeated once. After completion of all experiments, talk (with discussion; approx. 30 minutes) to test the candidate's understanding of the physics-related contents of the module. Talks that were not successfully completed can be repeated once. Both components of the assessment have to be successfully completed.
Allocation of places
--
Additional information
--
Workload
240 h
Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module appears in
Bachelor's degree (1 major) Physics (2015)

Compulsory Electives

(21 ECTS credits)

In the area of mandatory electives, students must achieve no less than 12 ECTS credits in graded modules. In the area of mandatory electives, students must complete modules worth a total of no less than 21 ECTS credits.

Module Group Chemistry, Computer Science, Mathematics

(ECTS credits)

<table>
<tr><th colspan="4">Module title</th><th>Abbreviation</th></tr>
<tr><td colspan="4">Experimental Chemistry</td><td>08-AC-ExChem-152-m01</td></tr>
<tr><th colspan="3">Module coordinator</th><th colspan="2">Module offered by</th></tr>
<tr><td colspan="3">lecturer of lecture "Experimentalchemie" (Experimental Chemistry)</td><td colspan="2">Institute of Inorganic Chemistry</td></tr>
<tr><th>ECTS</th><th>Method of grading</th><th colspan="3">Only after succ. compl. of module(s)</th></tr>
<tr><td>5</td><td>numerical grade</td><td colspan="3">--</td></tr>
<tr><th>Duration</th><th>Module level</th><th colspan="3">Other prerequisites</th></tr>
<tr><td>1 semester</td><td>undergraduate</td><td colspan="3">--</td></tr>
<tr><th colspan="5">Contents</th></tr>
<tr><td colspan="5">The module provides an overview of the fundamental knowledge of chemistry. Emphasis is placed on the material and particle level, metals, acid-base reactions, the periodic table, chemical equilibrium and complexometry.</td></tr>
<tr><th colspan="5">Intended learning outcomes</th></tr>
<tr><td colspan="5">The student understands the principles of the periodic table and can obtain information from it. He/she is proficient in basic models of the structure of matter and can describe them properly. He/she can depict chemical reactions using typical chemical formula language and interpret them by identifying the type of reaction.</td></tr>
<tr><th colspan="5">Courses (type, number of weekly contact hours, language — if other than German)</th></tr>
<tr><td colspan="5">V (4)</td></tr>
<tr><th colspan="5">Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)</th></tr>
<tr><td colspan="5">written examination (approx. 90 minutes)
Language of assessment: German and/or English</td></tr>
<tr><th colspan="5">Allocation of places</th></tr>
<tr><td colspan="5">--</td></tr>
<tr><th colspan="5">Additional information</th></tr>
<tr><td colspan="5">--</td></tr>
<tr><th colspan="5">Workload</th></tr>
<tr><td colspan="5">150 h</td></tr>
<tr><th colspan="5">Teaching cycle</th></tr>
<tr><td colspan="5">Teaching cycle: every year, winter semester</td></tr>
<tr><th colspan="5">Referred to in LPO I (examination regulations for teaching-degree programmes)</th></tr>
<tr><td colspan="5">--</td></tr>
<tr><th colspan="5">Module appears in</th></tr>
<tr><td colspan="5">Bachelor's degree (1 major) Biology (2011)
Bachelor's degree (1 major) Psychology (2010)
Bachelor's degree (1 major, 1 minor) Pedagogy (2013)
Bachelor's degree (1 major, 1 minor) Political and Social Studies (2013)
Bachelor's degree (1 major, 1 minor) Russian Language and Culture (2008)
Bachelor's degree (2 majors) Special Education (2009)
Magister Theologiae Catholic Theology (2013)
Bachelor's degree (2 majors) English and American Studies (2009)
Bachelor's degree (2 majors) German Language and Literature (2013)
Bachelor's degree (1 major) Geography (2015)
Bachelor's degree (1 major) Mathematics (2015)
Bachelor's degree (1 major) Musicology (2015)
Bachelor's degree (1 major) Physics (2015)</td></tr>
</table>

Bachelor's degree (1 major) Psychology (2015)
Bachelor's degree (1 major) Business Management and Economics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Music Education (2015)
Bachelor's degree (1 major) Computational Mathematics (2015)
Bachelor's degree (1 major) Political and Social Studies (2015)
Bachelor's degree (1 major) Functional Materials (2015)
Bachelor's degree (1 major) Academic Speech Therapy (2015)
Bachelor's degree (1 major) Indology/South Asian Studies (2015)
Bachelor's degree (1 major, 1 minor) Egyptology (2015)
Bachelor's degree (1 major, 1 minor) Pedagogy (2015)
Bachelor's degree (1 major, 1 minor) History (2015)
Bachelor's degree (1 major, 1 minor) Musicology (2015)
Bachelor's degree (1 major, 1 minor) Philosophy (2015)
Bachelor's degree (1 major, 1 minor) Pre- and Protohistoric Archaeology (2015)
Bachelor's degree (1 major, 1 minor) Ancient World (2015)
Bachelor's degree (1 major, 1 minor) Philosophy and Religion (2015)
Bachelor's degree (1 major, 1 minor) Theological Studies (2015)
Bachelor's degree (1 major, 1 minor) Political and Social Studies (2015)
Bachelor's degree (1 major, 1 minor) Russian Language and Culture (2015)
Bachelor's degree (1 major, 1 minor) German Language and Literature (2015)
Bachelor's degree (2 majors) Egyptology (2015)
Bachelor's degree (2 majors) Pedagogy (2015)
Bachelor's degree (2 majors) Protestant Theology (2015)
Bachelor's degree (2 majors) Musicology (2015)
Bachelor's degree (2 majors) Philosophy (2015)
Bachelor's degree (2 majors) Special Education (2015)
Bachelor's degree (2 majors) Pre- and Protohistoric Archaeology (2015)
Bachelor's degree (2 majors) Latin Philology (2015)
Bachelor's degree (2 majors) Music Education (2015)
Bachelor's degree (2 majors) Philosophy and Religion (2015)
Bachelor's degree (2 majors) Theological Studies (2015)
Bachelor's degree (2 majors) Political and Social Studies (2015)
Bachelor's degree (2 majors) Russian Language and Culture (2015)
Bachelor's degree (2 majors) Greek Philology (2015)
Bachelor's degree (2 majors) European Ethnology (2015)
Bachelor's degree (2 majors) Indology/South Asian Studies (2015)
Bachelor's degree (2 majors) Geography (2015)
Bachelor's degree (2 majors) French Studies (2015)
Bachelor's degree (2 majors) History (2015)
Bachelor's degree (2 majors) Sport Science (Focus on health and Pedagogics in Movement) (2015)
Bachelor's degree (2 majors) German Language and Literature (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major, 1 minor) French Studies (2016)
Bachelor's degree (2 majors) French Studies (2016)
Bachelor's degree (1 major, 1 minor) Italian Studies (2016)
Bachelor's degree (2 majors) Italian Studies (2016)
Bachelor's degree (1 major, 1 minor) Spanish Studies (2016)
Bachelor's degree (2 majors) Spanish Studies (2016)
Bachelor's degree (1 major) Romanic Languages (French/Italian) (2016)
Bachelor's degree (1 major) Romanic Languages (French/Spanish) (2016)
Bachelor's degree (1 major) Romanic Languages (Italian/Spanish) (2016)
Bachelor's degree (1 major) Business Information Systems (2016)

Bachelor's degree (1 major) Games Engineering (2016)
Bachelor's degree (1 major, 1 minor) English and American Studies (2016)
Bachelor's degree (2 majors) English and American Studies (2016)
Bachelor's degree (1 major) Media Communication (2016)
Bachelor's degree (1 major, 1 minor) Digital Humanities (2016)
Bachelor's degree (1 major) Biology (2017)
Bachelor's degree (1 major, 1 minor) Geography (2017)
Bachelor's degree (1 major, 1 minor) History of Medieval and Modern Art (2017)
Bachelor's degree (2 majors) History of Medieval and Modern Art (2017)
Bachelor's degree (2 majors) Comparative Indo-European Linguistics (2017)
Bachelor's degree (1 major) Aerospace Computer Science (2017)
Bachelor's degree (1 major, 1 minor) Museology and material culture (2017)
Bachelor's degree (1 major) Economathematics (2017)
Bachelor's degree (1 major) Games Engineering (2017)
Bachelor's degree (1 major) Computer Science (2017)
Bachelor's degree (1 major) Media Communication (2018)
Bachelor's degree (1 major) Biomedicine (2018)
Bachelor's degree (1 major) Human-Computer Systems (2018)
Bachelor's degree (2 majors) Classical Archaeology (2018)
Bachelor's degree (1 major, 1 minor) Classical Archaeology (2018)
Bachelor's degree (1 major, 1 minor) Digital Humanities (2018)
Bachelor's degree (2 majors) Digital Humanities (2018)
Bachelor's degree (1 major) Computer Science (2019)
Bachelor's degree (1 major, 1 minor) English and American Studies (2019)
Bachelor's degree (1 major) Indology/South Asian Studies (2019)
Bachelor's degree (1 major) Business Information Systems (2019)
Bachelor's degree (2 majors) Indology/South Asian Studies (2019)
Bachelor's degree (1 major) Business Management and Economics (2019)
Bachelor's degree (1 major) Modern China (2019)
Bachelor's degree (1 major) Biomedicine (2020)
Bachelor's degree (1 major) Pedagogy (2020)
Bachelor's degree (1 major) Political and Social Studies (2020)
Bachelor's degree (1 major) Business Information Systems (2020)
Bachelor's degree (1 major, 1 minor) Political and Social Studies (2020)
Bachelor's degree (2 majors) European Ethnology (2020)
Bachelor's degree (2 majors) Political and Social Studies (2020)
Bachelor's degree (2 majors) Special Education (2020)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major) Aerospace Computer Science (2020)
Bachelor's degree (1 major, 1 minor) Museology and material culture (2020)
Bachelor's degree (1 major, 1 minor) Pedagogy (2020)
Bachelor's degree (2 majors) Pedagogy (2020)
Bachelor's degree (1 major) Psychology (2020)
Bachelor's degree (1 major) Biology (2021)
Magister Theologiae Catholic Theology (2021)
Bachelor's degree (2 majors) History (2021)
Bachelor's degree (1 major, 1 minor) History (2021)
Bachelor's degree (1 major) Media Communication (2021)
Bachelor's degree (2 majors) Theological Studies (2021)
Bachelor's degree (1 major, 1 minor) Theological Studies (2021)
Bachelor's degree (1 major, 1 minor) English and American Studies (2021)

Bachelor's degree (2 majors) English and American Studies (2021)
Bachelor's degree (1 major) Functional Materials (2021)
Bachelor's degree (1 major) Computer Science und Sustainability (2021)
Bachelor's degree (2 majors) Comparative Indo-European Linguistics (2021)
Bachelor's degree (1 major) Quantum Technology (2021)
Bachelor's degree (2 majors) Special Education (2021)
Bachelor's degree (1 major) Business Information Systems (2021)
Bachelor's degree (1 major) Economathematics (2021)
Bachelor's degree (1 major) Business Management and Economics (2021)
Bachelor's degree (1 major) Human-Computer Systems (2022)
Bachelor's degree (1 major, 1 minor) Museology and material culture (2022)
Bachelor's degree (1 major) Biology (2022)
Bachelor's degree (1 major) Economathematics (2022)
Bachelor's degree (1 major) Mathematical Data Science (2022)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2022)
Bachelor's degree (2 majors) Ancient Near Eastern Archaeology (2022)
Bachelor's degree (1 major, 1 minor) Ancient World (2022)
Bachelor's degree (2 majors) Ancient Near Eastern Studies (2022)
Bachelor's degree (1 major) Franco-German studies: language, culture, digital competence (2022)
Bachelor's degree (1 major) European Law (2023)
Bachelor's degree (1 major, 1 minor) English and American Studies (2023)
Bachelor's degree (2 majors) English and American Studies (2023)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2023)
Bachelor's degree (1 major) Mathematics (2023)
Bachelor's degree (1 major) Business Information Systems (2023)
Bachelor's degree (1 major) Economathematics (2023)
Bachelor's degree (1 major, 1 minor) History of Medieval and Modern Art (2023)
Bachelor's degree (2 majors) History of Medieval and Modern Art (2023)
Bachelor's degree (2 majors) Special Education (2023)
Bachelor's degree (1 major) Business Management and Economics (2023)
Bachelor's degree (1 major) Geography (2023)
Bachelor's degree (2 majors) Geography (2023)
Bachelor's degree (1 major, 1 minor) Geography (2023)
Bachelor's degree (2 majors) European Ethnology/Empiric Cultural Studies (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)
Bachelor's degree (2 majors) German Language and Literature (2024)
Bachelor's degree (1 major, 1 minor) German Language and Literature (2024)
Bachelor's degree (1 major) Music Education (2024)
Bachelor's degree (2 majors) Music Education (2024)
Bachelor's degree (1 major, 1 minor) Music Education (2024)
Bachelor's degree (1 major) Indology/South Asian Studies (2024)
Bachelor's degree (2 majors) Indology/South Asian Studies (2024)
Bachelor's degree (1 major, 1 minor) Indology/South Asian Studies (2024)
Bachelor's degree (1 major, 1 minor) Ancient World (2024)
Bachelor's degree (2 majors) Digital Humanities (2024)
Bachelor's degree (1 major, 1 minor) Digital Humanities (2024)
Bachelor's degree (1 major) Midwifery (2024)
Bachelor's degree (2 majors) Greek Philology (2024)
Bachelor's degree (2 majors) Latin Philology (2024)
Bachelor's degree (1 major) Business Information Systems (2024)
Bachelor's degree (1 major) Economathematics (2024)
Bachelor's degree (1 major) Business Management and Economics (2024)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2024)

Bachelor's degree (1 major) Human-Computer-Interaction (2024)
Bachelor's degree (2 majors) Art Education (2024)
Bachelor's degree (1 major) Digital Business & Data Science (2024)
Bachelor's degree (1 major) Classics (2024)
Bachelor's degree (1 major) Diversity, Ethics and Religions (2024)
Bachelor's degree (1 major) Functional Materials (2025)
Bachelor's degree (1 major)   (2025)
Bachelor's degree (1 major, 1 minor) European Ethnology/Empiric Cultural Studies (2025)
Bachelor's degree (1 major) Pedagogy (2025)
Bachelor's degree (2 majors) Pedagogy (2025)
Bachelor's degree (1 major) Economathematics (2025)
Bachelor's degree (1 major) Academic Speech Therapy (2025)
Bachelor's degree (1 major, 1 minor) Pedagogy (2025)
Bachelor's degree (1 major) Games Engineering (2025)

Module title				Abbreviation
General and Analytical Chemistry for students of natural sciences (lab)				08-ACP-NF-152-m01
Module coordinator			**Module offered by**	
holder of the Chair of Anorganic Chemistry			Institute of Inorganic Chemistry	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
2	(not) successfully completed	08-AC-ExChem		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

This module gives students the opportunity to apply in practice the knowledge they have gained through the related lecture(s). After a safety briefing, the students autonomously conduct experiments in the laboratory. The course focuses on laboratory safety, simple lab techniques, the synthesis of simple substances and analyses of unknown substances.

Intended learning outcomes

Students are able to identify fundamental problems in chemistry and perform experiments to solve them. They have developed the ability to perform the necessary stoichiometric calculations and describe the chemical processes in an appropriate manner, both in written and oral form.

Courses (type, number of weekly contact hours, language — if other than German)

P (4)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Vortestate/Nachtestate (pre and post-experiment examination talks approx. 15 minutes each, log approx. 5 to 10 pages each) and assessment of practical performance (2 to 4 random examinations)
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

60 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)

Module title				Abbreviation
Organic Chemistry for students of medicine, biomedicine, dental medicine and natural sciences				08-OC-NF-152-m01
Module coordinator			**Module offered by**	
lecturer of lecture "Organische Chemie für Studierende der Medizin, Biomedizin, Zahnmedizin, Ingenieur- and Naturwissenschaften"			Institute of Organic Chemistry	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
3	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

This module provides students with an overview of the theoretical principles of organic chemistry.

Intended learning outcomes

Students have become familiar with the fundamental principles of organic chemistry.

Courses (type, number of weekly contact hours, language — if other than German)

V (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

90 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Psychology (2010)
Bachelor's degree (1 major, 1 minor) Pedagogy (2013)
Bachelor's degree (1 major, 1 minor) Political and Social Studies (2013)
Bachelor's degree (1 major, 1 minor) Russian Language and Culture (2008)
Bachelor's degree (2 majors) Special Education (2009)
Magister Theologiae Catholic Theology (2013)
First state examination for the teaching degree Grundschule English (2009)
First state examination for the teaching degree Grundschule Biology (2009)
First state examination for the teaching degree Grundschule Chemistry (2009)
First state examination for the teaching degree Grundschule Geography (2009)
First state examination for the teaching degree Grundschule Protestant Theology (2009)
First state examination for the teaching degree Grundschule German (2009)
First state examination for the teaching degree Grundschule History (2009)
First state examination for the teaching degree Grundschule History (2015)

First state examination for the teaching degree Grundschule Catholic Theology (2009)
First state examination for the teaching degree Grundschule Mathematics (2009)
First state examination for the teaching degree Grundschule Music (2009)
First state examination for the teaching degree Grundschule Physics (2009)
First state examination for the teaching degree Grundschule Social Science (2009)
First state examination for the teaching degree Grundschule Science of Sport (2009)
First state examination for the teaching degree Hauptschule English (2009)
First state examination for the teaching degree Hauptschule Biology (2009)
First state examination for the teaching degree Hauptschule Chemistry (2009)
First state examination for the teaching degree Hauptschule Geography (2009)
First state examination for the teaching degree Hauptschule Protestant Theology (2009)
First state examination for the teaching degree Hauptschule German (2009)
First state examination for the teaching degree Hauptschule History (2009)
First state examination for the teaching degree Hauptschule Catholic Theology (2009)
First state examination for the teaching degree Hauptschule Mathematics (2009)
First state examination for the teaching degree Hauptschule Music (2009)
First state examination for the teaching degree Hauptschule Physics (2009)
First state examination for the teaching degree Hauptschule Social Science (2009)
First state examination for the teaching degree Hauptschule Science of Sport (2009)
First state examination for the teaching degree Realschule English (2009)
First state examination for the teaching degree Realschule Biology (2009)
First state examination for the teaching degree Realschule Chemistry (2009)
First state examination for the teaching degree Realschule Geography (2009)
First state examination for the teaching degree Realschule Protestant Theology (2009)
First state examination for the teaching degree Realschule French Studies (2009)
First state examination for the teaching degree Realschule German (2009)
First state examination for the teaching degree Realschule History (2009)
First state examination for the teaching degree Realschule Computer Science (2012)
First state examination for the teaching degree Realschule Catholic Theology (2009)
First state examination for the teaching degree Realschule Mathematics (2009)
First state examination for the teaching degree Realschule Music (2009)
First state examination for the teaching degree Realschule Physics (2009)
First state examination for the teaching degree Realschule Science of Sport (2009)
First state examination for the teaching degree Gymnasium English (2009)
First state examination for the teaching degree Gymnasium Biology (2009)
First state examination for the teaching degree Gymnasium Chemistry (2009)
First state examination for the teaching degree Gymnasium Geography (2009)
First state examination for the teaching degree Gymnasium French Studies (2009)
First state examination for the teaching degree Gymnasium German (2009)
First state examination for the teaching degree Gymnasium History (2009)
First state examination for the teaching degree Gymnasium Greek Philology (2009)
First state examination for the teaching degree Gymnasium Computer Science (2009)
First state examination for the teaching degree Gymnasium Italian Studies (2009)
First state examination for the teaching degree Gymnasium Catholic Theology (2009)
First state examination for the teaching degree Gymnasium Latin Philology (2009)
First state examination for the teaching degree Gymnasium Mathematics (2012)
First state examination for the teaching degree Gymnasium Mathematics (2009)
First state examination for the teaching degree Gymnasium Music (2009)
First state examination for the teaching degree Gymnasium Physics (2009)
First state examination for the teaching degree Gymnasium Russian (2009)
First state examination for the teaching degree Gymnasium Social Science (2009)
First state examination for the teaching degree Gymnasium Spanish Studies (2009)
First state examination for the teaching degree Gymnasium Science of Sport (2009)

First state examination for the teaching degree Gymnasium Music Education, Advanced Studies (2009)
First state examination for the teaching degree Sonderpädagogik Pedagogy of Secondary Education (2009)
First state examination for the teaching degree Sonderpädagogik Pedagogy of Primary Education (2009)
First state examination for the teaching degree Sonderpädagogik Teaching at the German Mittelschule (2013)
First state examination for the teaching degree Mittelschule English (2013)
First state examination for the teaching degree Mittelschule Biology (2013)
First state examination for the teaching degree Mittelschule Chemistry (2013)
First state examination for the teaching degree Mittelschule Geography (2013)
First state examination for the teaching degree Mittelschule Protestant Theology (2013)
First state examination for the teaching degree Mittelschule German (2013)
First state examination for the teaching degree Mittelschule History (2013)
First state examination for the teaching degree Mittelschule Catholic Theology (2013)
First state examination for the teaching degree Mittelschule Mathematics (2013)
First state examination for the teaching degree Mittelschule Physics (2013)
First state examination for the teaching degree Mittelschule Social Science (2013)
First state examination for the teaching degree Mittelschule Science of Sport (2013)
Bachelor's degree (2 majors) English and American Studies (2009)
Bachelor's degree (2 majors) German Language and Literature (2013)
Bachelor's degree (1 major) Geography (2015)
Bachelor's degree (1 major) Mathematics (2015)
Bachelor's degree (1 major) Musicology (2015)
Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Psychology (2015)
Bachelor's degree (1 major) Business Management and Economics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Music Education (2015)
Bachelor's degree (1 major) Computational Mathematics (2015)
Bachelor's degree (1 major) Political and Social Studies (2015)
Bachelor's degree (1 major) Academic Speech Therapy (2015)
Bachelor's degree (1 major) Indology/South Asian Studies (2015)
Bachelor's degree (1 major, 1 minor) Egyptology (2015)
Bachelor's degree (1 major, 1 minor) Pedagogy (2015)
Bachelor's degree (1 major, 1 minor) History (2015)
Bachelor's degree (1 major, 1 minor) Musicology (2015)
Bachelor's degree (1 major, 1 minor) Philosophy (2015)
Bachelor's degree (1 major, 1 minor) Pre- and Protohistoric Archaeology (2015)
Bachelor's degree (1 major, 1 minor) Ancient World (2015)
Bachelor's degree (1 major, 1 minor) Philosophy and Religion (2015)
Bachelor's degree (1 major, 1 minor) Theological Studies (2015)
Bachelor's degree (1 major, 1 minor) Political and Social Studies (2015)
Bachelor's degree (1 major, 1 minor) Russian Language and Culture (2015)
Bachelor's degree (1 major, 1 minor) German Language and Literature (2015)
Bachelor's degree (2 majors) Egyptology (2015)
Bachelor's degree (2 majors) Pedagogy (2015)
Bachelor's degree (2 majors) Protestant Theology (2015)
Bachelor's degree (2 majors) Musicology (2015)
Bachelor's degree (2 majors) Philosophy (2015)
Bachelor's degree (2 majors) Special Education (2015)
Bachelor's degree (2 majors) Pre- and Protohistoric Archaeology (2015)
Bachelor's degree (2 majors) Latin Philology (2015)
Bachelor's degree (2 majors) Music Education (2015)
Bachelor's degree (2 majors) Philosophy and Religion (2015)
Bachelor's degree (2 majors) Theological Studies (2015)

Bachelor's degree (2 majors) Political and Social Studies (2015)
Bachelor's degree (2 majors) Russian Language and Culture (2015)
Bachelor's degree (2 majors) Greek Philology (2015)
Bachelor's degree (2 majors) European Ethnology (2015)
Bachelor's degree (2 majors) Indology/South Asian Studies (2015)
First state examination for the teaching degree Grundschule English (2015)
First state examination for the teaching degree Grundschule Biology (2015)
First state examination for the teaching degree Grundschule Chemistry (2015)
First state examination for the teaching degree Grundschule Geography (2015)
First state examination for the teaching degree Grundschule German (2015)
First state examination for the teaching degree Grundschule Catholic Theology (2015)
First state examination for the teaching degree Grundschule Mathematics (2015)
First state examination for the teaching degree Grundschule Pedagogy of Primary Education (2015)
First state examination for the teaching degree Grundschule Physics (2015)
First state examination for the teaching degree Grundschule Social Science (2015)
First state examination for the teaching degree Grundschule Didactics in English (Primary School) (2015)
First state examination for the teaching degree Grundschule Didactics in Biology (Primary School) (2015)
First state examination for the teaching degree Grundschule Didactics in Chemistry (Primary School) (2015)
First state examination for the teaching degree Grundschule Didactics in Geography (Primary School) (2015)
First state examination for the teaching degree Grundschule Didactics in German (Primary School) (2015)
First state examination for the teaching degree Grundschule Didactics in History (Primary School) (2015)
First state examination for the teaching degree Grundschule Didactics in Catholic Theology (Primary School) (2015)
First state examination for the teaching degree Grundschule Art Education in Primary School (2015)
First state examination for the teaching degree Grundschule Didactics in Science of Sport (Primary School) (2015)
First state examination for the teaching degree Grundschule Didactics in Mathematics (Primary School) (2015)
First state examination for the teaching degree Grundschule Music Education in Primary School (2015)
First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2015)
First state examination for the teaching degree Grundschule Didactics in Social Science (Primary School) (2015)
First state examination for the teaching degree Grundschule Science of Sport (2015)
First state examination for the teaching degree Realschule English (2015)
First state examination for the teaching degree Realschule Biology (2015)
First state examination for the teaching degree Realschule Chemistry (2015)
First state examination for the teaching degree Realschule Geography (2015)
First state examination for the teaching degree Realschule Protestant Theology (2015)
First state examination for the teaching degree Realschule French Studies (2015)
First state examination for the teaching degree Realschule German (2015)
First state examination for the teaching degree Realschule History (2015)
First state examination for the teaching degree Realschule Computer Science (2015)
First state examination for the teaching degree Realschule Catholic Theology (2015)
First state examination for the teaching degree Realschule Mathematics (2015)
First state examination for the teaching degree Realschule Physics (2015)
First state examination for the teaching degree Realschule Science of Sport (2015)
First state examination for the teaching degree Gymnasium English (2015)
First state examination for the teaching degree Gymnasium Biology (2015)
First state examination for the teaching degree Gymnasium Chemistry (2015)
First state examination for the teaching degree Gymnasium Geography (2015)
First state examination for the teaching degree Gymnasium French Studies (2015)
First state examination for the teaching degree Gymnasium German (2015)
First state examination for the teaching degree Gymnasium History (2015)
First state examination for the teaching degree Gymnasium Greek Philology (2015)
First state examination for the teaching degree Gymnasium Computer Science (2015)
First state examination for the teaching degree Gymnasium Italian Studies (2015)

First state examination for the teaching degree Gymnasium Catholic Theology (2015)
First state examination for the teaching degree Gymnasium Latin Philology (2015)
First state examination for the teaching degree Gymnasium Mathematics (2015)
First state examination for the teaching degree Gymnasium Physics (2015)
First state examination for the teaching degree Gymnasium Russian (2015)
First state examination for the teaching degree Gymnasium Social Science (2015)
First state examination for the teaching degree Gymnasium Spanish Studies (2015)
First state examination for the teaching degree Gymnasium Science of Sport (2015)
First state examination for the teaching degree Sonderpädagogik Pedagogy of Primary Education (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in German (Primary School) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Catholic Theology (Primary School) (2015)
First state examination for the teaching degree Sonderpädagogik Art Education in Primary School (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Science of Sport (Primary School) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Mathematics (Primary School) (2015)
First state examination for the teaching degree Sonderpädagogik Music Education in Primary School (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in English (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Ergonomics (Teaching at the German Mittelschule) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Biology (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Chemistry (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Geography (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Protestant Theology (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in German (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in History (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Catholic Theology (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Art Education in Middle School (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Science of Sport (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Mathematics (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Music Education in Middle School (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Social Science (Middle School) (2015)
First state examination for the teaching degree Sonderpädagogik Teaching at the German Mittelschule (2015)
First state examination for the teaching degree Mittelschule English (2015)
First state examination for the teaching degree Mittelschule Biology (2015)
First state examination for the teaching degree Mittelschule Chemistry (2015)
First state examination for the teaching degree Mittelschule Geography (2015)
First state examination for the teaching degree Mittelschule Protestant Theology (2015)
First state examination for the teaching degree Mittelschule German (2015)
First state examination for the teaching degree Mittelschule History (2015)
First state examination for the teaching degree Mittelschule Catholic Theology (2015)
First state examination for the teaching degree Mittelschule Mathematics (2015)
First state examination for the teaching degree Mittelschule Physics (2015)
First state examination for the teaching degree Mittelschule Social Science (2015)
First state examination for the teaching degree Mittelschule Didactics in English (Middle School) (2015)

First state examination for the teaching degree Mittelschule Ergonomics (Teaching at the German Mittelschule) (2015)
First state examination for the teaching degree Mittelschule Didactics in Biology (Middle School) (2015)
First state examination for the teaching degree Mittelschule Didactics in Chemistry (Middle School) (2015)
First state examination for the teaching degree Mittelschule Didactics in Geography (Middle School) (2015)
First state examination for the teaching degree Mittelschule Didactics in Protestant Theology (Middle School) (2015)
First state examination for the teaching degree Mittelschule Didactics in German (Middle School) (2015)
First state examination for the teaching degree Mittelschule Didactics in History (Middle School) (2015)
First state examination for the teaching degree Mittelschule Didactics in Catholic Theology (Middle School) (2015)
First state examination for the teaching degree Mittelschule Art Education in Middle School (2015)
First state examination for the teaching degree Mittelschule Didactics in Science of Sport (Middle School) (2015)
First state examination for the teaching degree Mittelschule Didactics in Mathematics (Middle School) (2015)
First state examination for the teaching degree Mittelschule Music Education in Middle School (2015)
First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2015)
First state examination for the teaching degree Mittelschule Didactics in Social Science (Middle School) (2015)
First state examination for the teaching degree Mittelschule Science of Sport (2015)
First state examination for the teaching degree Mittelschule Teaching at the German Mittelschule (2015)
Bachelor's degree (2 majors) Geography (2015)
Bachelor's degree (2 majors) French Studies (2015)
Bachelor's degree (2 majors) History (2015)
Bachelor's degree (2 majors) Sport Science (Focus on health and Pedagogics in Movement) (2015)
Bachelor's degree (2 majors) German Language and Literature (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
First state examination for the teaching degree Grundschule Protestant Theology (2015)
First state examination for the teaching degree Grundschule Music (2015)
First state examination for the teaching degree Grundschule Didactics in Protestant Theology (Primary School) (2015)
First state examination for the teaching degree Realschule Music (2015)
First state examination for the teaching degree Gymnasium Music (2015)
First state examination for the teaching degree Gymnasium Music Education, Advanced Studies (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Protestant Theology (Primary School) (2015)
First state examination for the teaching degree Mittelschule Music (2015)
Bachelor's degree (1 major, 1 minor) French Studies (2016)
Bachelor's degree (2 majors) French Studies (2016)
Bachelor's degree (1 major, 1 minor) Italian Studies (2016)
Bachelor's degree (2 majors) Italian Studies (2016)
Bachelor's degree (1 major, 1 minor) Spanish Studies (2016)
Bachelor's degree (2 majors) Spanish Studies (2016)
Bachelor's degree (1 major) Romanic Languages (French/Italian) (2016)
Bachelor's degree (1 major) Romanic Languages (French/Spanish) (2016)
Bachelor's degree (1 major) Romanic Languages (Italian/Spanish) (2016)
Bachelor's degree (1 major) Business Information Systems (2016)
First state examination for the teaching degree Gymnasium French Studies (2016)
First state examination for the teaching degree Gymnasium Italian Studies (2016)
First state examination for the teaching degree Gymnasium Spanish Studies (2016)
First state examination for the teaching degree Realschule French Studies (2016)
Bachelor's degree (1 major) Games Engineering (2016)
Bachelor's degree (1 major, 1 minor) English and American Studies (2016)
Bachelor's degree (2 majors) English and American Studies (2016)
First state examination for the teaching degree Grundschule English (2016)

First state examination for the teaching degree Grundschule Didactics in English (Primary School) (2016)
First state examination for the teaching degree Realschule English (2016)
First state examination for the teaching degree Gymnasium English (2016)
First state examination for the teaching degree Mittelschule English (2016)
First state examination for the teaching degree Mittelschule Didactics in English (Middle School) (2016)
First state examination for the teaching degree Sonderpädagogik Didactics in English (Middle School) (2016)
Bachelor's degree (1 major) Media Communication (2016)
Bachelor's degree (1 major, 1 minor) Digital Humanities (2016)
Bachelor's degree (1 major, 1 minor) Geography (2017)
Bachelor's degree (1 major, 1 minor) History of Medieval and Modern Art (2017)
Bachelor's degree (2 majors) History of Medieval and Modern Art (2017)
Bachelor's degree (2 majors) Comparative Indo-European Linguistics (2017)
Bachelor's degree (1 major) Aerospace Computer Science (2017)
Bachelor's degree (1 major, 1 minor) Museology and material culture (2017)
Bachelor's degree (1 major) Economathematics (2017)
Bachelor's degree (1 major) Games Engineering (2017)
Bachelor's degree (1 major) Computer Science (2017)
First state examination for the teaching degree Gymnasium Greek Philology (2018)
Bachelor's degree (1 major) Media Communication (2018)
Bachelor's degree (1 major) Biomedicine (2018)
Bachelor's degree (1 major) Human-Computer Systems (2018)
Bachelor's degree (2 majors) Classical Archaeology (2018)
Bachelor's degree (1 major, 1 minor) Classical Archaeology (2018)
Bachelor's degree (1 major, 1 minor) Digital Humanities (2018)
Bachelor's degree (2 majors) Digital Humanities (2018)
First state examination for the teaching degree Grundschule Physics (2018)
First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2018)
First state examination for the teaching degree Realschule Physics (2018)
First state examination for the teaching degree Gymnasium Physics (2018)
First state examination for the teaching degree Mittelschule Physics (2018)
First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2018)
First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2018)
Bachelor's degree (1 major) Computer Science (2019)
First state examination for the teaching degree Gymnasium Mathematics (2019)
Bachelor's degree (1 major, 1 minor) English and American Studies (2019)
Module studies (Bachelor) Chemistry (2019)
Bachelor's degree (1 major) Indology/South Asian Studies (2019)
Bachelor's degree (1 major) Business Information Systems (2019)
Bachelor's degree (2 majors) Indology/South Asian Studies (2019)
Bachelor's degree (1 major) Business Management and Economics (2019)
Bachelor's degree (1 major) Modern China (2019)
Module studies (Bachelor) Orientierungsstudien (2020)
Bachelor's degree (1 major) Biomedicine (2020)
Bachelor's degree (1 major) Pedagogy (2020)
Bachelor's degree (1 major) Political and Social Studies (2020)
Bachelor's degree (1 major) Business Information Systems (2020)
Bachelor's degree (1 major, 1 minor) Political and Social Studies (2020)
Bachelor's degree (2 majors) European Ethnology (2020)
Bachelor's degree (2 majors) Political and Social Studies (2020)
Bachelor's degree (2 majors) Special Education (2020)
First state examination for the teaching degree Mittelschule Biology (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in Biology (Middle School) (2020 (Prüfungsordnungsversion 2015))

First state examination for the teaching degree Mittelschule Didactics in Biology (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Chemistry (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Didactics in Chemistry (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule German (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Didactics in German (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule English (2020 (Prüfungsordnungsversion 2016))
First state examination for the teaching degree Mittelschule Didactics in English (Middle School) (2020 (Prüfungsordnungsversion 2016))
First state examination for the teaching degree Mittelschule Protestant Theology (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Didactics in Protestant Theology (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Geography (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Didactics in Geography (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule History (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Didactics in History (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Catholic Theology (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Didactics in Catholic Theology (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Mathematics (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Didactics in Mathematics (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Art Education in Middle School (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Science of Sport (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Didactics in Science of Sport (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Music (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Music Education in Middle School (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Mittelschule Teaching at the German Mittelschule (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in English (Middle School) (2020 (Prüfungsordnungsversion 2016))
First state examination for the teaching degree Sonderpädagogik Didactics in Chemistry (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in Geography (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in Protestant Theology (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in German (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in History (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in Catholic Theology (Middle School) (2020 (Prüfungsordnungsversion 2015))

First state examination for the teaching degree Sonderpädagogik Art Education in Middle School (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in Science of Sport (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in Mathematics (Middle School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Music Education in Middle School (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Teaching at the German Mittelschule (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Art Education in Primary School (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Music Education in Primary School (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in Science of Sport (Primary School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in German (Primary School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in Mathematics (Primary School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Pedagogy of Primary Education (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in Protestant Theology (Primary School) (2020 (Prüfungsordnungsversion 2015))
First state examination for the teaching degree Sonderpädagogik Didactics in Catholic Theology (Primary School) (2020 (Prüfungsordnungsversion 2015))
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major) Aerospace Computer Science (2020)
Bachelor's degree (1 major, 1 minor) Museology and material culture (2020)
First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2020)
First state examination for the teaching degree Grundschule Physics (2020)
First state examination for the teaching degree Gymnasium Physics (2020)
First state examination for the teaching degree Realschule Physics (2020)
First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2020)
First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2020)
First state examination for the teaching degree Mittelschule Physics (2020)
Bachelor's degree (1 major, 1 minor) Pedagogy (2020)
Bachelor's degree (2 majors) Pedagogy (2020)
First state examination for the teaching degree Grundschule Political and Social Studies (2020)
First state examination for the teaching degree Grundschule Didactics in Political and Social Studies (Primary School) (2020)
First state examination for the teaching degree Sonderpädagogik MS-Didaktik Career and Economics (2020)
First state examination for the teaching degree Sonderpädagogik Didactics in Political and Social Studies (Secondary School) (2020)
First state examination for the teaching degree Mittelschule MS-Didaktik Career and Economics (2020)
First state examination for the teaching degree Mittelschule Didactics in Political and Social Studies (Secondary School) (2020)
First state examination for the teaching degree Mittelschule Political and Social Studies (2020)
First state examination for the teaching degree Gymnasium Political and Social Studies (2020)
Bachelor's degree (1 major) Psychology (2020)
Magister Theologiae Catholic Theology (2021)
Bachelor's degree (2 majors) History (2021)

Bachelor's degree (1 major, 1 minor) History (2021)
First state examination for the teaching degree Grundschule History (2021)
First state examination for the teaching degree Gymnasium History (2021)
First state examination for the teaching degree Realschule History (2021)
First state examination for the teaching degree Mittelschule History (2021)
Bachelor's degree (1 major) Media Communication (2021)
Bachelor's degree (2 majors) Theological Studies (2021)
Bachelor's degree (1 major, 1 minor) Theological Studies (2021)
Bachelor's degree (1 major, 1 minor) English and American Studies (2021)
Bachelor's degree (2 majors) English and American Studies (2021)
First state examination for the teaching degree Grundschule Pedagogy of Primary Education (2021)
First state examination for the teaching degree Gymnasium English (2021)
First state examination for the teaching degree Gymnasium Philosophy and Ethics (2021)
Bachelor's degree (1 major) Computer Science und Sustainability (2021)
Bachelor's degree (2 majors) Comparative Indo-European Linguistics (2021)
Bachelor's degree (1 major) Quantum Technology (2021)
Bachelor's degree (2 majors) Special Education (2021)
Bachelor's degree (1 major) Business Information Systems (2021)
Bachelor's degree (1 major) Economathematics (2021)
Bachelor's degree (1 major) Business Management and Economics (2021)
First state examination for the teaching degree Sonderpädagogik Pedagogy of Primary Education (2021)
Bachelor's degree (1 major) Human-Computer Systems (2022)
Bachelor's degree (1 major, 1 minor) Museology and material culture (2022)
Bachelor's degree (1 major) Economathematics (2022)
Bachelor's degree (1 major) Mathematical Data Science (2022)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2022)
First state examination for the teaching degree Gymnasium Philosophy and Ethics (2022)
Bachelor's degree (2 majors) Ancient Near Eastern Archaeology (2022)
Bachelor's degree (1 major, 1 minor) Ancient World (2022)
Bachelor's degree (2 majors) Ancient Near Eastern Studies (2022)
Bachelor's degree (1 major) Franco-German studies: language, culture, digital competence (2022)
First state examination for the teaching degree Gymnasium Russian (2023)
First state examination for the teaching degree Gymnasium Mathematics (2023)
First state examination for the teaching degree Gymnasium English (2023)
First state examination for the teaching degree Realschule English (2023)
First state examination for the teaching degree Grundschule English (2023)
First state examination for the teaching degree Grundschule Didactics in English (Primary School) (2023)
First state examination for the teaching degree Mittelschule English (2023)
First state examination for the teaching degree Mittelschule Didactics in English (Middle School) (2023)
First state examination for the teaching degree Sonderpädagogik Didactics in English (Middle School) (2023)
First state examination for the teaching degree Gymnasium Geography (2023)
First state examination for the teaching degree Realschule Geography (2023)
First state examination for the teaching degree Grundschule Geography (2023)
First state examination for the teaching degree Mittelschule Geography (2023)
Bachelor's degree (1 major) European Law (2023)
Bachelor's degree (1 major, 1 minor) English and American Studies (2023)
Bachelor's degree (2 majors) English and American Studies (2023)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2023)
Bachelor's degree (1 major) Mathematics (2023)
Bachelor's degree (1 major) Business Information Systems (2023)
Bachelor's degree (1 major) Economathematics (2023)
Bachelor's degree (1 major, 1 minor) History of Medieval and Modern Art (2023)
Bachelor's degree (2 majors) History of Medieval and Modern Art (2023)

Bachelor's degree (2 majors) Special Education (2023)
Bachelor's degree (1 major) Business Management and Economics (2023)
Bachelor's degree (1 major) Geography (2023)
Bachelor's degree (2 majors) Geography (2023)
Bachelor's degree (1 major, 1 minor) Geography (2023)
Bachelor's degree (2 majors) European Ethnology/Empiric Cultural Studies (2023)
First state examination for the teaching degree Grundschule German (2024)
First state examination for the teaching degree Gymnasium German (2024)
First state examination for the teaching degree Realschule German (2024)
First state examination for the teaching degree Sonderpädagogik Didactics in German (Middle School) (2024)
First state examination for the teaching degree Mittelschule Didactics in German (Middle School) (2024)
First state examination for the teaching degree Grundschule Didactics in German (Primary School) (2024)
First state examination for the teaching degree Sonderpädagogik Didactics in German (Primary School) (2024)
First state examination for the teaching degree Mittelschule German (2024)
Bachelor's degree (1 major) Mathematical Physics (2024)
Bachelor's degree (2 majors) German Language and Literature (2024)
Bachelor's degree (1 major, 1 minor) German Language and Literature (2024)
Bachelor's degree (1 major) Music Education (2024)
Bachelor's degree (2 majors) Music Education (2024)
Bachelor's degree (1 major, 1 minor) Music Education (2024)
First state examination for the teaching degree Grundschule Music Education in Primary School (2024)
First state examination for the teaching degree Sonderpädagogik Music Education in Primary School (2024)
First state examination for the teaching degree Mittelschule Music Education in Middle School (2024)
First state examination for the teaching degree Sonderpädagogik Music Education in Middle School (2024)
Bachelor's degree (1 major) Indology/South Asian Studies (2024)
Bachelor's degree (2 majors) Indology/South Asian Studies (2024)
Bachelor's degree (1 major, 1 minor) Indology/South Asian Studies (2024)
Bachelor's degree (1 major, 1 minor) Ancient World (2024)
Bachelor's degree (2 majors) Digital Humanities (2024)
Bachelor's degree (1 major, 1 minor) Digital Humanities (2024)
Bachelor's degree (1 major) Midwifery (2024)
Bachelor's degree (2 majors) Greek Philology (2024)
Bachelor's degree (2 majors) Latin Philology (2024)
First state examination for the teaching degree Gymnasium Latin Philology (2024)
Bachelor's degree (1 major) Business Information Systems (2024)
Bachelor's degree (1 major) Economathematics (2024)
Bachelor's degree (1 major) Business Management and Economics (2024)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2024)
First state examination for the teaching degree Gymnasium English (2024)
First state examination for the teaching degree Mittelschule MS-Didaktik Career and Economics (2024)
First state examination for the teaching degree Sonderpädagogik MS-Didaktik Career and Economics (2024)
First state examination for the teaching degree Grundschule History (2024)
First state examination for the teaching degree Gymnasium History (2024)
First state examination for the teaching degree Realschule History (2024)
First state examination for the teaching degree Mittelschule History (2024)
First state examination for the teaching degree Mittelschule Didactics in History (Middle School) (2024)
First state examination for the teaching degree Sonderpädagogik Didactics in History (Middle School) (2024)
First state examination for the teaching degree Grundschule Didactics in History (Primary School) (2024)
First state examination for the teaching degree Gymnasium Greek Philology (2024)
Bachelor's degree (1 major) Human-Computer-Interaction (2024)
First state examination for the teaching degree Grundschule Art Education in Primary School (2024)
First state examination for the teaching degree Sonderpädagogik Art Education in Primary School (2024)
First state examination for the teaching degree Sonderpädagogik Art Education in Middle School (2024)

First state examination for the teaching degree Mittelschule Art Education in Middle School (2024)
Bachelor's degree (2 majors) Art Education (2024)
Bachelor's degree (1 major) Digital Business & Data Science (2024)
Bachelor's degree (1 major) Classics (2024)
Bachelor's degree (1 major) Diversity, Ethics and Religions (2024)
Bachelor's degree (1 major)   (2025)
Bachelor's degree (1 major, 1 minor) European Ethnology/Empiric Cultural Studies (2025)
Bachelor's degree (1 major) Pedagogy (2025)
Bachelor's degree (2 majors) Pedagogy (2025)
Bachelor's degree (1 major) Economathematics (2025)
Bachelor's degree (1 major) Academic Speech Therapy (2025)
Bachelor's degree (1 major, 1 minor) Pedagogy (2025)
Bachelor's degree (1 major) Games Engineering (2025)

Module title				Abbreviation
Introduction to Computer Science for Students of all Faculties				10-I-EIN-152-m01
Module coordinator			**Module offered by**	
Dean of Studies Informatik (Computer Science)			Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
10	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Foundations of computer science including representation of information and websites (HTML, XML, EBNF), databases, algorithms and data structures, programming (Java).

Intended learning outcomes

The students are familiar with the fundamentals of computer science, e. g. in the areas of representation of information and websites (HTML, XML, EBNF), databases, algorithms and data structures, programming in Java.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Geography (2015)
Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Functional Materials (2015)
Master's degree (1 major) Psychology (2015)
Bachelor's degree (1 major, 1 minor) Pre- and Protohistoric Archaeology (2015)
Bachelor's degree (1 major, 1 minor) Pre- and Protohistoric Archaeology (Minor, 2015)
Bachelor's degree (2 majors) Pre- and Protohistoric Archaeology (2015)
Bachelor's degree (1 major, 1 minor) Digital Humanities (2018)
Bachelor's degree (1 major, 1 minor) Digital Humanities (Minor, 2018)
Bachelor's degree (2 majors) Digital Humanities (2018)
Bachelor's degree (1 major) Functional Materials (2021)
Master's degree (1 major) Psychology (2022)
exchange program Psychology (2023)
Bachelor's degree (1 major) Geography (2023)
Bachelor's degree (1 major) Functional Materials (2025)

Module title				Abbreviation
Computational Mathematics				10-M-COM-152-m01

Module coordinator	Module offered by
Dean of Studies Mathematik (Mathematics)	Institute of Mathematics

ECTS	Method of grading	Only after succ. compl. of module(s)
4	(not) successfully completed	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

Introduction to modern mathematical software for symbolic computation (e. g. Mathematica or Maple) and numerical computation (e. g. Matlab) to supplement the basic modules in analysis and linear algebra (10-M-ANA-G and 10-M-LNA-G). Computer-based solution of problems in linear algebra, geometry, analysis, in particular differential and integral calculus; visualisation of functions.

Intended learning outcomes

The student learns the use of advanced modern mathematical software packages, and is able to assess their fields of application to solve mathematical problems.

Courses (type, number of weekly contact hours, language — if other than German)

V (1) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

project in the form of programming exercises (approx. 20 to 25 hours)
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

120 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 f)

Module appears in

Bachelor's degree (1 major) Mathematics (2015)
Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Economathematics (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major) Computational Mathematics (2015)
Bachelor's degree (1 major) Functional Materials (2015)
First state examination for the teaching degree Gymnasium Mathematics (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major) Economathematics (2017)
First state examination for the teaching degree Gymnasium Mathematics (2019)
Bachelor's degree (1 major) Physics (2020)

Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major) Functional Materials (2021)
Bachelor's degree (1 major) Quantum Technology (2021)
Bachelor's degree (1 major) Economathematics (2021)
Bachelor's degree (1 major) Economathematics (2022)
Bachelor's degree (1 major) Mathematical Data Science (2022)
exchange program Mathematics (2023)
First state examination for the teaching degree Gymnasium Mathematics (2023)
Bachelor's degree (1 major) Mathematics (2023)
Bachelor's degree (1 major) Economathematics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)
Bachelor's degree (1 major) Economathematics (2024)
Bachelor's degree (1 major) Functional Materials (2025)
Bachelor's degree (1 major) Economathematics (2025)

Module title				Abbreviation
Numerical Mathematics 1 for students of other subjects				10-M-NUM1af-152-m01
Module coordinator			**Module offered by**	
Dean of Studies Mathematik (Mathematics)			Institute of Mathematics	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
10	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Solution of systems of linear equations and curve fitting problems, nonlinear equations and systems of equations, interpolation with polynomials, splines and trigonometric functions, numerical integration.

Intended learning outcomes

The student is acquainted with the fundamental concepts and methods in numerical mathematics, applies them to practical problems and knows about their typical fields of application.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 180 minutes, usually chosen) or
b) oral examination of one candidate each (15 to 30 minutes) or
c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Computer Science (2015)
Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Aerospace Computer Science (2015)
Bachelor's degree (1 major) Functional Materials (2015)
Bachelor's degree (1 major) Aerospace Computer Science (2017)
Bachelor's degree (1 major) Computer Science (2017)
Bachelor's degree (1 major) Computer Science (2019)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Aerospace Computer Science (2020)
Bachelor's degree (1 major) Functional Materials (2021)

Bachelor's degree (1 major) Computer Science und Sustainability (2021)
Bachelor's degree (1 major) Quantum Technology (2021)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2022)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2023)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2024)
Bachelor's degree (1 major) Functional Materials (2025)

Module title				Abbreviation
Numerical Mathematics 2 for students of other subjects				10-M-NUM2af-152-m01
Module coordinator			**Module offered by**	
Dean of Studies Mathematik (Mathematics)			Institute of Mathematics	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
10	numerical grade		--	
Duration	**Module level**		**Other prerequisites**	
1 semester	undergraduate		--	

Contents

Eigenvalue problems, linear programming, methods for initial value problems for ordinary differential equations, boundary value problems.

Intended learning outcomes

The student is able to draw a distinction between the different concepts of numerical mathematics and knows about their advantages and limitations concerning the possibilities of application in different fields of natural and engineering sciences and economics.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 180 minutes, usually chosen) or
b) oral examination of one candidate each (15 to 30 minutes) or
c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Aerospace Computer Science (2015)
Bachelor's degree (1 major) Functional Materials (2015)
Bachelor's degree (1 major) Aerospace Computer Science (2017)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Aerospace Computer Science (2020)
Bachelor's degree (1 major) Functional Materials (2021)
Bachelor's degree (1 major) Quantum Technology (2021)
Bachelor's degree (1 major) Functional Materials (2025)

Module title				Abbreviation
Programming course for students of Mathematics and other subjects				10-M-PRG-152-m01
Module coordinator			**Module offered by**	
Dean of Studies Mathematik (Mathematics)			Institute of Mathematics	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
3	(not) successfully completed	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Basics of a modern programming language (e. g. C).

Intended learning outcomes

The student is able to work independently on small programming exercises and standard programming problems in mathematics.

Courses (type, number of weekly contact hours, language — if other than German)

P (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

project in the form of programming exercises (approx. 20 to 25 hours)
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

90 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 f)

Module appears in

Bachelor's degree (1 major) Mathematics (2015)
Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Economathematics (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major) Computational Mathematics (2015)
Bachelor's degree (1 major) Functional Materials (2015)
First state examination for the teaching degree Gymnasium Mathematics (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major) Economathematics (2017)
First state examination for the teaching degree Gymnasium Mathematics (2019)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major) Functional Materials (2021)

Bachelor's degree (1 major) Quantum Technology (2021) Bachelor's degree (1 major) Economathematics (2021) Bachelor's degree (1 major) Economathematics (2022) Bachelor's degree (1 major) Mathematical Data Science (2022) exchange program Mathematics (2023) First state examination for the teaching degree Gymnasium Mathematics (2023) Bachelor's degree (1 major) Mathematics (2023) Bachelor's degree (1 major) Economathematics (2023) Bachelor's degree (1 major) Mathematical Physics (2024) Bachelor's degree (1 major) Economathematics (2024) Bachelor's degree (1 major) Functional Materials (2025) Bachelor's degree (1 major) Economathematics (2025)

Module title				Abbreviation
Modeling and Computational Science				10-M-MWR-152-m01
Module coordinator			**Module offered by**	
Dean of Studies Mathematik (Mathematics)			Institute of Mathematics	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
8	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		
Contents				
Aspects of mathematical modelling of technical or scientific processes. Basic principles of modelling, aspects of scaling the modelling, asymptotic series, classical methods for solving ordinary and partial differential equations, fundamental methods for numerical solution of partial differential equations and the resulting systems of linear equations.				
Intended learning outcomes				
The student masters the fundamental mathematical methods and techniques to simulate processes from natural and engineering sciences on a computer.				
Courses (type, number of weekly contact hours, language — if other than German)				
V (4) + Ü (2) Module taught in: German and/or English				
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)				
a) written examination (approx. 90 to 180 minutes, usually chosen) or b) oral examination of one candidate each (15 to 30 minutes) or c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate) Language of assessment: German and/or English creditable for bonus				
Allocation of places				
--				
Additional information				
--				
Workload				
240 h				
Teaching cycle				
--				
Referred to in LPO I (examination regulations for teaching-degree programmes)				
--				
Module appears in				
Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major) Computational Mathematics (2015) Bachelor's degree (1 major) Mathematical Physics (2016) Master's degree (1 major) Functional Materials (2016) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Mathematical Physics (2020)				

Module title	Abbreviation
Group Theory	11-GRT-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	graduate	--

Contents

Group theory. Finite groups. Lie groups. Lie algebra. Depiction. Tensors. Classification theorem. Applications.

Intended learning outcomes

The students know the basics of group theory, especially of Lie groups. They are able to identify problems of group theory and to solve them by using the acquired methods. They are able to apply group theory to the formulation and processing of physical problems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + R (2)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
exchange program Physics (2023)

Bachelor's degree (1 major) Mathematical Physics (2024)

Module title			**Abbreviation**
Programming Course for natural sciences			10-I-NPP-182-m01
Module coordinator			**Module offered by**
Dean of Studies Informatik (Computer Science)			Institute of Computer Science
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	(not) successfully completed	--	
Duration	**Module level**	**Other prerequisites**	
1-2 semester	undergraduate	--	

Contents

The programming language Java. Independent creation of small to middle-sized, high-quality Java programs.

Intended learning outcomes

The students are able to independently develop small to middle-sized, high-quality Java programs.

Courses (type, number of weekly contact hours, language — if other than German)

P (3)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

practical examination (programming exercises, approx. 120 hours) and written examination (approx. 30 to 60 minutes)

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Physics (2020)

Module title				Abbreviation
Fundamentals of Programming				10-I-GdP-172-m01
Module coordinator			**Module offered by**	
holder of the Chair of Computer Science II			Institute of Computer Science	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
5	numerical grade		--	
Duration	**Module level**		**Other prerequisites**	
1 semester	undergraduate		--	

Contents

Data types, control structures, foundations of procedural programming, selected topics of C, introduction to object orientation in Java, selected topics of C++, further Java concepts, digression: scripting languages.

Intended learning outcomes

The students possess a fundamental knowledge about programming languages (in particular Java, C and C++) and are able to independently develop average to high level Java programs.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 49 I Nr. 1 b)
§ 69 I Nr. 1 b)

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Aerospace Computer Science (2017)
Bachelor's degree (1 major) Computer Science (2017)
Bachelor's degree (1 major) Computer Science (2019)
Bachelor's degree (1 major) Business Information Systems (2020)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Aerospace Computer Science (2020)
Bachelor's degree (1 major) Computer Science und Sustainability (2021)
Bachelor's degree (1 major) Business Information Systems (2021)
Bachelor's degree (1 major) Mathematical Data Science (2022)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2022)

Bachelor's degree (1 major) Artificial Intelligence and Data Science (2023)
Bachelor's degree (1 major) Mathematics (2023)
Bachelor's degree (1 major) Business Information Systems (2023)
Bachelor's degree (1 major) Business Information Systems (2024)
Bachelor's degree (1 major) Artificial Intelligence and Data Science (2024)
Bachelor's degree (1 major) Economathematics (2025)

Module Group Applied Physics

(ECTS credits)

Module title			Abbreviation
Computational Physics			11-CP-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

- Introduction to programming on the basis of C++ / Java /Mathematica
- numerical solution of differential equations
- simulation of chaotic systems
- generation of random numbers
- random walk
- many-particle processes and reaction-diffusion model

Intended learning outcomes

The students have knowledge of two major programming languages and know algorithms important for Physics. They have knowledge of numerical standard methods and are able to apply computer-assisted processes to the solution of physical problems, e.g. algorithms for solving numerical problems of Physics.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)

Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020)
exchange program Physics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)

Module title				Abbreviation
Electronic Circuits				11-EL-152-m01

Module coordinator	**Module offered by**
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	**Method of grading**	**Only after succ. compl. of module(s)**
6	numerical grade	--

Duration	**Module level**	**Other prerequisites**
1 semester	undergraduate	--

Contents

Principles of electronic components and circuits. Analogous circuit technology: Passive (resistors, capacitors, coils and diodes) and active components (bipolar and field-effect transistors, operational amplifiers). Digital circuits: different types of gates and CMOS circuits. Microcontroller

Intended learning outcomes

The students have knowledge of the practical setup of electronic circuits from the field of analogous and digital circuit technology.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)

Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020)
Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)

Module title			Abbreviation
Laboratory and Measurement Technology			11-LMT-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

Introduction to electronic and optical measuring methods of physical metrology, vacuum technology and cryogenics, cryogenics, light sources, spectroscopic methods and measured value acquisition.

Intended learning outcomes

The students have competencies in the field of electronic and optical measuring methods of physical metrology, vacuum technology and cryogenics, cryogenics, light sources, spectroscopic methods and measured value acquisition.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)
Master's degree (1 major) Functional Materials (2016)
Bachelor's degree (1 major) Physics (2020)

Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020)
Bachelor's degree (1 major) Quantum Technology (2021)
Master's degree (1 major) Functional Materials (2022)
exchange program Physics (2023)
Master's degree (1 major) Functional Materials (2025)

Module title				Abbreviation
Introduction to Labview				11-LVW-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	graduate	--		

Contents

The module comprises basic and advanced courses. The basic course "NI LabVIEW Basic 1" is the first level of each LabVIEW learning phase. LabVIEW Basic provides a systematic introduction to the functions and application fields of the development environment of LabVIEW. The students become acquainted with dataflow programming and with common LabVIEW architectures. They learn to develop LabVIEW applications for various application fields, from assessment and measurement applications up to data collection, device control, data recording and measurement analysis. In the advanced course "NI LabVIEW Core 2", the students learn to develop comprehensive standalone applications, including the graphical development environment LabVIEW. The course builds upon LabVIEW Basic 1 and provides an introduction to the most common development technologies, in order to enable the students to successfully implement and distribute LabVIEW applications for different application fields. Course topics include techniques and procedures for the optimisation of application performance, e.g. through an optimised reuse of existing codes, usage of file I/O functions, principles of data management, event computing and methods of error handling. After finishing the course, the students have the ability to apply LabVIEW functions according to individual requirements, which enables a fast and productive application development.

Intended learning outcomes

The students have specific and advanced knowledge in the application field of LabVIEW. They know the principles of working with LabVIEW and are able to develop applications, e.g. for recording and analysing measuring data.

Courses (type, number of weekly contact hours, language — if other than German)

V (1) + R (3)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module appears in
Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Nanostructure Technology (2015) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Quantum Technology (2021) exchange program Physics (2023)

Module title				Abbreviation
Laboratory and Measurement Technology in Biophysics				11-LMB-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	graduate	--		

Contents

The lecture covers relevant principles of molecular and cellular biology as well as the physical principles of biophysical procedures for the examination and manipulation of biological systems. The main topics are optical measuring techniques and sensors, methods of single-particle detection, special microscoping techniques and methods of structure elucidation of biomolecules.

Intended learning outcomes

The students know the principles of molecular and cellular biology as well as the physical principles of biophysical procedures for the examination and manipulation of biological systems. They have knowledge of optical measuring techniques and their applications and are able to apply techniques of structure elucidation to simple biomolecules.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)

Master's degree (1 major) Functional Materials (2016)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
Master's degree (1 major) Functional Materials (2022)
exchange program Physics (2023)
Master's degree (1 major) Functional Materials (2025)

Module title				Abbreviation
Principles of Two- and Three-Dimensional Röntgen Imaging				11-ZDR-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	graduate	--		

Contents

Physics of X-ray generation (X-ray tubes, synchrotron). Physics of the interaction between X-rays and matter (photon absorption, scattering), physics of X-ray detection. Mathematics of reconstruction algorithms (filtered rear projection, Fourier reconstruction, iterative methods). Image processing (image data pre-processing, feature extraction, visualisation,...). Applications of X-ray imaging in the industrial sector (component testing, material characterisation, metrology, biology, ...). Radiation protection and biological radiation effect (dose, ...).

Intended learning outcomes

The students know the principles of generating X-rays and of their interactions with matter. They know imaging techniques using X-rays and methods of image processing as well as application areas of these methods.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Master's degree (1 major) Functional Materials (2016)

Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
Master's degree (1 major) Functional Materials (2022)
exchange program Physics (2023)
Master's degree (1 major) Functional Materials (2025)

Module title				Abbreviation
Imaging Methods at the Synchroton				11-BMS-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Periodic and aperiodic signals. Fundamentals of discrete and exact Fourier transform. Basics of digital signal and image processing. Discretisation of signals / sampling theorem (Shannon). Homogeneous and linear filter, the convolution product. Tapering functions and interpolation of images. The Parsival theorem, correlation and energetic aspects. Statistical signals, image noise, moments, stationary signals. Tomography: Hankel and Radon transform.

Intended learning outcomes

The students know the principles of digital image and signal processing. They know the ways of functioning and applications of different image processing methods and are able to apply them in practice.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Master's degree (1 major) Functional Materials (2016)

Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
Master's degree (1 major) Functional Materials (2022)
exchange program Physics (2023)
Master's degree (1 major) Functional Materials (2025)

Module title			Abbreviation
Methods of Non-Destructive Material Testing			11-ZMB-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

Principles of non-destructive material and component testing. Thermography. Neutron radiography. X-ray testing. Ultrasound. Optical testing, laser. Image processing.

Intended learning outcomes

The students have basic knowledge of the generation and interaction processes of different types of radiation (heat, X-ray, terahertz), particles (neutrons) or ultrasound waves with materials. They know the applied methods for the detection of radiation types, particles and ultrasound waves and are able to apply them to basic problems of material testing and characterisation.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

120 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Master's degree (1 major) Functional Materials (2016)
Bachelor's degree (1 major) Physics (2020)

Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
Master's degree (1 major) Functional Materials (2022)
exchange program Physics (2023)
Master's degree (1 major) Functional Materials (2025)

Module title	Abbreviation
Imaging Sensors in Infrared	11-ASI-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
3	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

Infrared cameras are important experimental and technical tools, e.g. for measuring temperatures. The spectral range of infrared ranges from the visible spectrum, where the Sun is dominating as the natural source of light, up to microwaves and radiowaves with artificial emitters. There is distinct and sometimes dominating emission from bodies with ambient temperature in the infrared spectrum. The lecture provides an introduction to the physical optics of this spectral range and discusses: Peculiarities of infrared cameras and thermal images, different types of sensors (bolometer, quantum well, superlattice) as well as the evaluation of such sensors on the basis of neurophysiological aspects.

Intended learning outcomes

The students have specific and advanced knowledge in the field of infrared spectral imaging. They know various technologies and detector structures as well as their application areas.

Courses (type, number of weekly contact hours, language — if other than German)

V (2)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

90 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)

Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)

Module title				Abbreviation
Principles of Image Processing				11-EBV-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
3	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Introduction to image processing. Pictures as two-dimensional signals; digitalisation. Two-dimensional Fourier transform. Histogram equalisation (e.g. image brightening) and pixel connectivity (e.g. noise reduction). Automatic image recognition: Segmentation, classification. Technological image generation. Applications (e.g. motion tracking). Three-dimensional images.

Intended learning outcomes

The students have specific and advanced knowledge in the field of image processing. They know the principles and theory of signal processing for images and have corresponding knowledge of image generation. They are able to independently work with literature, they understand the characteristics of image processing with commercial software and are able to process images for the analysis of experiments with imaging measuring methods.

Courses (type, number of weekly contact hours, language — if other than German)

V (2)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

90 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)

Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)

Module title	**Abbreviation**
Principles of Pattern Classification	11-KVM-152-m01

Module coordinator	**Module offered by**
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	**Method of grading**	**Only after succ. compl. of module(s)**
3	numerical grade	--

Duration	**Module level**	**Other prerequisites**
1 semester	undergraduate	--

Contents

Signals such as images, but also acoustic records, spectra, electrical measurements often contain recurring patterns. These patterns are often classified and analysed by observers, e.g. by a doctor when analysing an ECG. More and more automatic procedures are adopted to take on these tasks and classify patterns. The lecture will discuss principles of different classifiers such as "minimum distance" and "maximum likelihood".

Intended learning outcomes

The students have specific and advanced knowledge in the field of pattern recognition. They know methods of classifying patterns in measuring data as well as ways to automatise these processes. They are able to apply these methods to practical problems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

90 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)

Module title				Abbreviation
Statistics, Data Analysis and Computer Physics				11-SDC-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
4	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	graduate	--		

Contents

Statistics, data analysis and computer physics.

Intended learning outcomes

The students have specific and advanced knowledge in the field of statistics, data analysis and Computational Physics.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

120 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)

Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)

Module Group Astrophysics

(ECTS credits)

Module title				Abbreviation
Astrophysics				11-AP-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

History of astronomy, coordinates and time measurement, the Solar System, exoplanets, astronomical scales, telescopes and detectors, stellar structure and atmospheres, stellar evolution and end stages, interstellar medium, molecular clouds, structure of the milky way, the local universe, the expanding universe, galaxies, active galactic nuclei, large-scale structures, cosmology.

Intended learning outcomes

The students are familiar with the modern world view of Astrophysics. They know methods and tools for astrophysical observations and evaluations. They are able to use these methods to plan and analyse own observations. They are familiar with the physics and development of the main astrophysical objects such as stars and galaxies.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + R (2)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes)
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 1 h)
§ 22 II Nr. 2 f)
§ 22 II Nr. 3 f)

Module appears in

Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major) Aerospace Computer Science (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) First state examination for the teaching degree Grundschule Physics (2015) First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2015) First state examination for the teaching degree Realschule Physics (2015) First state examination for the teaching degree Gymnasium Physics (2015) First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2015) First state examination for the teaching degree Mittelschule Physics (2015) First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2015) Bachelor's degree (1 major) Mathematical Physics (2016) Master's degree (1 major) Nanostructure Technology (2016) Bachelor's degree (1 major) Aerospace Computer Science (2017) First state examination for the teaching degree Grundschule Physics (2018) First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2018) First state examination for the teaching degree Realschule Physics (2018) First state examination for the teaching degree Gymnasium Physics (2018) First state examination for the teaching degree Mittelschule Physics (2018) First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2018) First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2018) Master's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor's degree (1 major) Aerospace Computer Science (2020) First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2020) First state examination for the teaching degree Grundschule Physics (2020) First state examination for the teaching degree Gymnasium Physics (2020) First state examination for the teaching degree Realschule Physics (2020) First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2020) First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2020) First state examination for the teaching degree Mittelschule Physics (2020) Master's degree (1 major) Quantum Technology (2021) exchange program Physics (2023) Bachelor's degree (1 major) Mathematical Physics (2024)

Module title				Abbreviation
Laboratory Course Astrophysics				11-APP-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	(not) successfully completed	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	graduate	--		

Contents

Astrophysical experiments in the fields of detectors, telescopes, methodology, analysis and astronomic observations.

Intended learning outcomes

The students have mastered experimental methods of Astrophysics and are able to analyse and interpret the measuring data and present the results. They are familiar with the working methods of observational Astronomy and with basic techniques of detecting electromagnetic radiation. They are able to plan and evaluate observations and measurements and to present the results.

Courses (type, number of weekly contact hours, language — if other than German)

P (4)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) Preparing, performing and evaluating the experiments will be considered successfully completed if a Testat (exam) is passed. Experiments that were not successfully completed can be repeated once or
b) discussion to test the candidate's understanding of the physics-related contents and results of the experiment (approx. 20 minutes).
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Physics (2020)
exchange program Physics (2023)

Module Group Particle Physics

(ECTS credits)

Module title				Abbreviation
Particle Physics (Standard Model)				11-TPS-152-m01
Module coordinator			**Module offered by**	
Managing Directors of the Institute of Applied Physics and the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
8	numerical grade		--	
Duration		**Module level**	**Other prerequisites**	
1 semester		undergraduate	--	

Contents

Theoretical description of the Standard Model
Electroweak symmetry breaking through the Higgs mechanism
parity Violation
Bhabha scattering
Z-Line Shape and forward / reverse asymmetry
Higgs production and decay
Experimental setup and results of key experiments to test the Standard Model and for determining its parameters
Search for the Higgs boson

Intended learning outcomes

The students know the theoretical fundamental laws of the standard model of Particle Physics and the key experiments that have established and confirmed the standard model. They are able to interpret experimental or theoretical results in the framework of the standard model and know its validity and limits.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + R (2)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

240 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in
Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2016) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major) Mathematical Physics (2024)

Module title				**Abbreviation**
Particle Radiation Detectors				11-DTS-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
4	numerical grade		--	
Duration		**Module level**	**Other prerequisites**	
1 semester		graduate	--	

Contents

Principles of interaction between particles and matter. Particle detectors for space and time measurement, determination of momentum, energy and particle identification. Conception of particle detectors in examples.

Intended learning outcomes

The students know the physical principles and the basic structure of particle detectors. They know the functions and applications of different types of detectors, they can explain the measurement of physical values and have basic knowledge of the conception of detector systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

120 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Physics (2020)
exchange program Physics (2023)

Module title	Abbreviation
Theory of Relativity	11-RTTB-232-m01

Module coordinator	Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

Mathematical Foundations
Differential forms
Brief Summary of the special relativity
Elements of differential geometry
Electrodynamics as an example of a relativistic gauge theory
Field equations of the fundamental structure of general relativity
Stellar equilibrium and other astrophysical applications
Introduction to cosmology

Intended learning outcomes

Familiarity with the basic physical and mathematical concepts of general relativity. Mathematical understanding of the formulation in terms of differential forms. Understanding of the formal similarity between electrodynamics and the theory of general relativity, viewing both of them as gauge theories. Application of the theory to simple models of stellar equilibrium. First contact with elements of cosmology.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: In the semester in which the course is offered and in the subsequent semester

Allocation of places

--

Additional information

Approval from examination committee required

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module appears in
Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major) Mathematical Physics (2016) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Mathematical Physics (2020) exchange program Physics (2023) Bachelor's degree (1 major) Mathematical Physics (2024)

Module Group Semiconductor Physics

(ECTS credits)

Module title				Abbreviation
Semiconductor Lasers and Photonics				11-HLF-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	graduate	--		

Contents

This lecture discusses the principles of laser physics, based on the example of semiconductor lasers, and current developments regarding components. The principles of lasers are described on the basis of a general laser model, which will then be extended to special aspects of semiconductor lasers. Basic concepts such as threshold condition, characteristic curve and laser efficiency are derived from coupled rate equations for charge carriers and photons. Other topics of the lecture are optical processes in semiconductors, layer and ridge waveguides, laser resonators, mode selection, dynamic properties as well as technology for the generation of semiconductor lasers. The lecture closes with current topics of laser research such as quantum dot lasers, quantum cascade lasers, terahertz lasers or high-performance lasers.

Intended learning outcomes

The students have advanced knowledge of the principles of semiconductor-laser physics. They can apply their knowledge to modern questions and know the applications in the current development of components.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Nanostructure Technology (2015) Master's degree (1 major) Functional Materials (2016) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Quantum Technology (2021) Master's degree (1 major) Functional Materials (2022) exchange program Physics (2023) Master's degree (1 major) Functional Materials (2025)

Module title				Abbreviation
Fundamentals of Semiconductor Physics				11-HLP-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

1. Symmetry properties
2. Crystal formation and electronic band structure
3. Optical excitations and their coupling effects
4. Electron-phonon coupling
5. Temperature-dependent transport properties
6. (Semi-)magnetic semiconductors

Intended learning outcomes

The students are familiar with the principles of Semiconductor Physics. They understand the structure of semiconductors and know their physical properties and effects. They know important applications.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)

Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)

Module title	Abbreviation
Physics of Semiconductor Devices	11-SPD-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

Based on the fundamentals of Semiconductor Physics, the lecture provides an insight into semiconductor key technologies and discusses the main components in the fields of electronics and photonics on the basis of examples. The basic part introduces the crystal structures and band and phonon dispersions of technologically relevant semiconductors. The following part discusses the principles of charge transport involving non-equilibrium effects based on the charge carrier density of the thermal equilibrium. The part on technology gives an insight into the methods of production of semiconductor materials and presents the most important methods of planar technology. It discusses the way of functioning of the following components, sorted according to volume components, interface components and application fields: Rectifier diodes, Zener diodes, varistor, varactor, tunnel diodes, IMPATT, Baritt- and Gunn diodes, photodiode, solar cell, LED, semiconductor injection laser, transistor, JFET, Thyristor, Diac, Triac, Schottky diode, MOSFET, MESFET, HFET. It highlights the importance of low-dimensional charge carrier systems for technology and basic research and shows recent developments in the components sector.

Intended learning outcomes

The students know the characteristics of semiconductors, they have gained an overview of the electronic and phonon band structures of important semiconductors and the resulting electronic, optical and thermal properties. They know the principles of charge transport as well as the Poisson, Boltzmann and continuity equation for the solution of questions. They have gained insights into the methods of semiconductor production and are familiar with the theories of planar technology and recent developments in this field, they have a basic understanding of component production. They understand the structure and way of functioning of the main components of electronics (diode, transistor, field-effect transistor, thyristor, diac, triac), of microwave applications (tunnel, Impatt, Baritt or Gunn diode) and of optoelectronics (photo diode, solar cell, light-emitting diode, semiconductor injection laser), they know the realisation possibilities of low-dimensional charge carrier systems on the basis of semiconductors and their technological relevance, they are familiar with current developments in the field of components.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places
--
Additional information
--
Workload
180 h
Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module appears in
Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Nanostructure Technology (2015) Master's degree (1 major) Functional Materials (2016) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Quantum Technology (2021) Master's degree (1 major) Functional Materials (2022) exchange program Physics (2023) Master's degree (1 major) Functional Materials (2025)

Module title				Abbreviation
Crystal Growth, thin Layers and Lithography				11-KDS-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	--

Contents

Crystal growth, thin films, lithography.

Intended learning outcomes

The students have knowledge of crystal growth and the techniques and methods to control crystal growth in the laboratory. They have methodological knowledge of the production and examination of thin layers and know techniques and applications of lithography.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)

Module Group Solid State and Nanostructure Physics

(ECTS credits)

Module title				**Abbreviation**
Nanoanalytics				11-NAN-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	graduate	--		

Contents

Principles of analytic procedures in the field of nanostructure physics, imaging techniques from a microscopic level up to an atomic level, examination of chemical composition, spectroscopy of electronic properties, usage of X-ray methods. - Physics and material systems on the nanoscale. - Scanning probes: Atomic force microscopy. Scanning tunneling microscopy. - Electron probes: Scanning electron microscope. Transmission electron microscope. - Secondary ions - mass spectrometry - X-ray methods: Synchrotron spectroscopy. Photoemission. X-ray absorption

Intended learning outcomes

The students have basic knowledge of modern research methods for different nanostructures up to an atomic level. They know microscoping procedures that are used in practice in labs and the industry as well as spectroscopic methods for the determination of electronic properties. They are able to evaluate the efficiency of different research methods.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015) Bachelor's degree (1 major) Nanostructure Technology (2015) Master's degree (1 major) Functional Materials (2016) Bachelor's degree (1 major) Physics (2020) Bachelor's degree (1 major) Nanostructure Technology (2020) Bachelor's degree (1 major) Quantum Technology (2021) exchange program Physics (2023)

Module title	Abbreviation
Principles of Energy Technologies	11-ENT-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	graduate	--

Contents

Physical principles of energy conservation and energy conversion, energy transport and energy storage as well as renewable resources of energy. We also discuss aspects of optimising materials (e.g. nanostructured insulating materials, selective layers, highly activated carbons). The course is especially suitable for teaching degree students. Energy conservation via thermal insulation. Thermodynamic energy efficiency. Fossil fired energy converters. Nuclear power plants. Hydroelectricity. Wind turbines. Photovoltaics. Solar thermal: Heat. Solar thermal: Electricity. Biomass. Geothermal energy. Energy storage. Energy transport

Intended learning outcomes

The students know the principles of different methods of energy technology, especially energy conversion, transport and storage. They understand the structures of corresponding installations and are able to compare them.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes)
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 1 h)
§ 22 II Nr. 2 f)
§ 22 II Nr. 3 f)

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
First state examination for the teaching degree Grundschule Physics (2015)
First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2015)
First state examination for the teaching degree Realschule Physics (2015)
First state examination for the teaching degree Gymnasium Physics (2015)
First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2015)
First state examination for the teaching degree Mittelschule Physics (2015)
First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2015)
Master's degree (1 major) Functional Materials (2016)
First state examination for the teaching degree Grundschule Physics (2018)
First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2018)
First state examination for the teaching degree Realschule Physics (2018)
First state examination for the teaching degree Gymnasium Physics (2018)
First state examination for the teaching degree Mittelschule Physics (2018)
First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2018)
First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2018)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2020)
First state examination for the teaching degree Grundschule Physics (2020)
First state examination for the teaching degree Gymnasium Physics (2020)
First state examination for the teaching degree Realschule Physics (2020)
First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2020)
First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2020)
First state examination for the teaching degree Mittelschule Physics (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
Master's degree (1 major) Functional Materials (2022)
exchange program Physics (2023)
Master's degree (1 major) Functional Materials (2025)

Module Group Current Topics in Physics

(ECTS credits)

Module title				Abbreviation
Current Topics in Experimental Physics				11-BXE5-152-m01
Module coordinator			**Module offered by**	
chairperson of examination committee			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
5	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	Approval from examination committee required.		

Contents

Current topics of Experimental Physics. Accredited academic achievements, e.g. in case of change of university or study abroad.

Intended learning outcomes

The students have advanced competencies corresponding to the requirements of a module of Experimental Physics of the Bachelor's programme. They have knowledge of a current subdiscipline of Experimental Physics and understand the measuring and/or evaluation methods necessary to acquire this knowledge. They are able to classify the subject-specific contexts and know the application areas.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + R (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Module studies (Bachelor) Physics (2019)
Bachelor's degree (1 major) Physics (2020)

Module title				Abbreviation
Current Topics in Experimental Physics				11-BXE6-152-m01
Module coordinator			**Module offered by**	
chairperson of examination committee			Faculty of Physics and Astronomy	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
6	numerical grade		--	
Duration	**Module level**		**Other prerequisites**	
1 semester	undergraduate		Approval from examination committee required.	

Contents

Current topics of Experimental Physics. Accredited academic achievements, e.g. in case of change of university or study abroad.

Intended learning outcomes

The students have advanced competencies corresponding to the requirements of a module of Experimental Physics of the Bachelor's programme. They have knowledge of a current subdiscipline of Experimental Physics and understand the measuring and/or evaluation methods necessary to acquire this knowledge. They are able to classify the subject-specific contexts and know the application areas.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Module studies (Bachelor) Physics (2019)
Bachelor's degree (1 major) Physics (2020)

Module title				Abbreviation
Current Topics in Experimental Physics				11-BXE8-152-m01
Module coordinator			**Module offered by**	
chairperson of examination committee			Faculty of Physics and Astronomy	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
8	numerical grade		--	
Duration	**Module level**		**Other prerequisites**	
1 semester	undergraduate		Approval from examination committee required.	

Contents

Current topics of Experimental Physics. Accredited academic achievements, e.g. in case of change of university or study abroad.

Intended learning outcomes

The students have advanced competencies corresponding to the requirements of a module of Experimental Physics of the Bachelor's programme. They have knowledge of a current subdiscipline of Experimental Physics and understand the measuring and/or evaluation methods necessary to acquire this knowledge. They are able to classify the subject-specific contexts and know the application areas.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + R (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

240 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Module studies (Bachelor) Physics (2019)
Bachelor's degree (1 major) Physics (2020)

Module title				Abbreviation
Current Topics in Theoretical Physics				11-BXT5-152-m01
Module coordinator			**Module offered by**	
chairperson of examination committee			Faculty of Physics and Astronomy	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
5	numerical grade		--	
Duration		**Module level**	**Other prerequisites**	
1 semester		undergraduate	Approval from examination committee required.	

Contents

Current topics of Theoretical Physics. Accredited academic achievements, e.g. in case of change of university or study abroad.

Intended learning outcomes

The students have advanced competencies corresponding to the requirements of a module of Theoretical Physics of the Bachelor's programme. They have advanced specialist knowledge of a subdiscipline of Theoretical Physics and have mastered the required methods. They are able to apply the acquired methods to current problems of Theoretical Physics.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + R (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Module studies (Bachelor) Physics (2019)
Bachelor's degree (1 major) Physics (2020)

Module title				Abbreviation
Current Topics in Theoretical Physics				11-BXT6-152-m01
Module coordinator			**Module offered by**	
chairperson of examination committee			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	Approval from examination committee required.		

Contents

Current topics of Theoretical Physics. Accredited academic achievements, e.g. in case of change of university or study abroad.

Intended learning outcomes

The students have advanced competencies corresponding to the requirements of a module of Theoretical Physics of the Bachelor's programme. They have advanced specialist knowledge of a subdiscipline of Theoretical Physics and have mastered the required methods. They are able to apply the acquired methods to current problems of Theoretical Physics.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Module studies (Bachelor) Physics (2019)
Bachelor's degree (1 major) Physics (2020)

Module title				**Abbreviation**
Current Topics in Theoretical Physics				11-BXT8-152-m01
Module coordinator			**Module offered by**	
chairperson of examination committee			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
8	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	Approval from examination committee required.		

Contents

Current topics of Theoretical Physics. Accredited academic achievements, e.g. in case of change of university or study abroad.

Intended learning outcomes

The students have advanced competencies corresponding to the requirements of a module of Theoretical Physics of the Bachelor's programme. They have advanced specialist knowledge of a subdiscipline of Theoretical Physics and have mastered the required methods. They are able to apply the acquired methods to current problems of Theoretical Physics.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + R (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

240 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Module studies (Bachelor) Physics (2019)
Bachelor's degree (1 major) Physics (2020)

Module title			**Abbreviation**
Selected Topics in Astrophysics			11-CSA6-152-m01
Module coordinator		**Module offered by**	
chairperson of examination committee		Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
6	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	Approval from examination committee required.	

Contents

Selected topics of Astrophysics.

Intended learning outcomes

The students have basic knowledge of a current field of Astrophysics and understand the measuring and evaluation methods necessary to acquire this knowledge. They are able to classify the subject-specific contexts and know the application areas.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Module studies (Bachelor) Physics (2019)
Bachelor's degree (1 major) Physics (2020)

Module title	Abbreviation
Selected Topics in Particle Physics	11-CST6-152-m01

Module coordinator	Module offered by
chairperson of examination committee	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--

Duration	Module level	Other prerequisites
1 semester	undergraduate	Approval from examination committee required.

Contents

Selected topics of Particle Physics.

Intended learning outcomes

The students have basic knowledge of a special field of Elementary Particle Physics and of the experimental or theoretical methods necessary to acquire this knowledge. They are able to classify the subject-specific contexts and know the application areas.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Module studies (Bachelor) Physics (2019)
Bachelor's degree (1 major) Physics (2020)

Module title				Abbreviation
Selected Topics in Solid State Physics				11-CSF6-152-m01
Module coordinator			**Module offered by**	
chairperson of examination committee			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	Approval from examination committee required.		

Contents

Selected topics of Solid-State Physics.

Intended learning outcomes

The students have basic knowledge of a specialist field of Solid-State Physics and understand the measuring and evaluation methods necessary to acquire this knowledge. They are able to classify the subject-specific contexts and know the application areas.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Module studies (Bachelor) Physics (2019)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Quantum Technology (2021)
Module studies (Bachelor) Quantum Technology (2021)

Module title				Abbreviation
Selected Topics in Theoretical Physics				11-CSTh6-152-m01
Module coordinator			**Module offered by**	
chairperson of examination committee			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	Approval from examination committee required.		

Contents

Selected topics of Theoretical Physics.

Intended learning outcomes

The students have basic knowledge of a special field of Theoretical Physics and have mastered the necessary mathematical methods. They are able to apply the acquired methods to current problems of Theoretical Physics.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + R (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Module studies (Bachelor) Physics (2019)
Bachelor's degree (1 major) Physics (2020)

Key Skills Area

(20 ECTS credits)

General Key Skills

(5 ECTS credits)

In addition to the modules listed below, students may also take modules offered by JMU as part of the pool of general transferable skills (ASQ).

General Key Skills (subject-specific)

(ECTS credits)

Module title				Abbreviation
Preparatory Course Mathematics				11-P-VKM-152-m01
Module coordinator			**Module offered by**	
Managing Directors of the Institute of Applied Physics and the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
2	(not) successfully completed		--	
Duration		**Module level**	**Other prerequisites**	
1 semester		undergraduate	--	

Contents

Principles of mathematics and elementary calculation methods from school and partially beyond, especially for the introduction to and preparation for the modules of Experimental and Theoretical Physics.
1. Basic geometry and algebra
2. Coordinate systems and complex numbers
3. Vectors - vectored values
4. Differential calculus
5. Integral calculus

Intended learning outcomes

The students know the principles of mathematics and elementary calculation methods which are required for successfully studying Theoretical and Experimental Physics.

Courses (type, number of weekly contact hours, language — if other than German)

T (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) exercises (successful completion of approx. 50% of approx. 6 exercise sheets) or
b) talk (approx. 15 minutes)
Assessment offered: Once a year, winter semester

Allocation of places

--

Additional information

--

Workload

60 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 1 h)
§ 22 II Nr. 2 f)
§ 22 II Nr. 3 f)

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)
First state examination for the teaching degree Grundschule Physics (2015)
First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2015)
First state examination for the teaching degree Realschule Physics (2015)

First state examination for the teaching degree Gymnasium Physics (2015) First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2015) First state examination for the teaching degree Mittelschule Physics (2015) First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2015) Bachelor's degree (1 major) Mathematical Physics (2016) First state examination for the teaching degree Grundschule Physics (2018) First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2018) First state examination for the teaching degree Realschule Physics (2018) First state examination for the teaching degree Gymnasium Physics (2018) First state examination for the teaching degree Mittelschule Physics (2018) First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2018) First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2018)

Module title				Abbreviation
Fit for Industry				11-FFI-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
3	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Occupations for physicists. Occupations in the industrial sector and at universities. Orientation in the industrial environment. Product development. Income opportunities. Project management. Marketing, corporate strategy and management. Management tasks and soft skills.

Intended learning outcomes

The students know about the requirements of jobs in the industry and are able to make decisions for their own future based on their knowledge.

Courses (type, number of weekly contact hours, language — if other than German)

V (1) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

90 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)

Module title			Abbreviation
Project Management in Practice			11-PMP-152-m01

Module coordinator	Module offered by
Managing Director of the Institute of Applied Physics	Faculty of Physics and Astronomy

ECTS	Method of grading	Only after succ. compl. of module(s)
3	(not) successfully completed	--

Duration	Module level	Other prerequisites
1 semester	graduate	--

Contents

Technical project management in practice, contents: Definitions, terms, cardinal errors in project management, project schedule, kick-off and stakeholder, teams and resources, milestones and planning, visualisation and reporting, conflicts, success factors, technical and economic controlling, target agreement, balanced score cards, solving exemplary cases

Intended learning outcomes

The students have knowledge of technical project management. They are familiar with different methods and success factors and are able to define, plan and successfully conduct a project.

Courses (type, number of weekly contact hours, language — if other than German)

V (1) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or
b) oral examination of one candidate each (approx. 30 minutes) or
c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
d) project report (approx. 8 to 10 pages) or
e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English
Assessment offered: In the semester in which the course is offered and in the subsequent semester

Allocation of places

--

Additional information

--

Workload

90 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)

Bachelor's degree (1 major) Quantum Technology (2021)

Module title				Abbreviation
General Competences for Physicists				11-BASQ5-152-m01
Module coordinator			**Module offered by**	
chairperson of examination committee			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
5	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	Approval from examination committee required.		

Contents

General competencies for physicists.

Intended learning outcomes

The students have general competencies corresponding to the requirements of a module of Physics of the Bachelor's programme. They have knowledge of a current subdiscipline of Physics and of the required understanding of this topic. They are able to classify the subject-specific contexts and know the application areas.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + R (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Physics (2020)

Subject-specific Key Skills

(15 ECTS credits)

Module title				Abbreviation
Mathematical Methods of Physics				11-M-MR-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
6	(not) successfully completed	--		
Duration	**Module level**	**Other prerequisites**		
2 semester	undergraduate	--		

Contents

Principles of mathematics and basic calculation methods beyond the school curriculum, especially for the introduction to and preparation of the modules of Theoretical Physics and Classical or Experimental Physics.

Intended learning outcomes

The students have knowledge of the principles of mathematics and elementary calculation methods which are required in Theoretical and Experimental Physics.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (1) + V (2) + Ü (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) exercises (successful completion of approx. 50% of approx. 13 exercise sheets) or
b) talk (approx. 15 minutes)

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 53 I Nr. 1 a)
§ 77 I Nr. 1 a)

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)
First state examination for the teaching degree Grundschule Physics (2015)
First state examination for the teaching degree Realschule Physics (2015)
First state examination for the teaching degree Gymnasium Physics (2015)
First state examination for the teaching degree Mittelschule Physics (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
First state examination for the teaching degree Grundschule Physics (2018)
First state examination for the teaching degree Realschule Physics (2018)
First state examination for the teaching degree Gymnasium Physics (2018)

First state examination for the teaching degree Mittelschule Physics (2018)

Module title				Abbreviation
Seminar Experimental/Theoretical Physics				11-HS-152-m01
Module coordinator			**Module offered by**	
Managing Directors of the Institute of Applied Physics and the Institute of Theoretical Physics and Astrophysics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
5	numerical grade		--	
Duration		**Module level**	**Other prerequisites**	
1 semester		undergraduate	Admission prerequisite to assessment: regular attendance (minimum 85% of sessions).	

Contents

Current issues of Theoretical/Experimental Physics.

Intended learning outcomes

The students have advanced knowledge of a specialist field of Experimental or Theoretical Physics. They are able to independently acquire this knowledge and to summarise it in an oral presentation.

Courses (type, number of weekly contact hours, language — if other than German)

S (2)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

talk with discussion (30 to 45 minutes)

Allocation of places

--

Additional information

Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's registration for assessment into effect. Only those students that meet the respective prerequisites can successfully register for an assessment. Students who did not register for an assessment or whose registration for an assessment was not put into effect will not be admitted to the respective assessment. If a student takes an assessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered.

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020)
exchange program Physics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)

Module title				Abbreviation
Data and Error Analysis				11-P-FR1-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**		**Only after succ. compl. of module(s)**	
2	(not) successfully completed		--	
Duration	**Module level**		**Other prerequisites**	
1 semester	undergraduate		Admission prerequisite to assessment: completion of exercises (approx. 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the semester.	

Contents

Types of errors, error approximation and propagation, graphic representations, linear regression, mean values and standard deviation.

Intended learning outcomes

The students are able to evaluate measuring results on the basis of error propagation and of the principles of statistics and to draw, present and discuss the conclusions.

Courses (type, number of weekly contact hours, language — if other than German)

V (1) + Ü (1)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places

--

Additional information

Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's registration for assessment into effect. Only those students that meet the respective prerequisites can successfully register for an assessment. Students who did not register for an assessment or whose registration for an assessment was not put into effect will not be admitted to the respective assessment. If a student takes an assessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered.

Workload

60 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 53 I Nr. 1 c)
§ 77 I Nr. 1 d)

Module appears in

Bachelor's degree (1 major) Mathematics (2015)
Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)

Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major) Computational Mathematics (2015)
Bachelor's degree (1 major) Aerospace Computer Science (2015)
Bachelor's degree (1 major) Functional Materials (2015)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)
First state examination for the teaching degree Grundschule Physics (2015)
First state examination for the teaching degree Realschule Physics (2015)
First state examination for the teaching degree Gymnasium Physics (2015)
First state examination for the teaching degree Mittelschule Physics (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major) Aerospace Computer Science (2017)
First state examination for the teaching degree Grundschule Physics (2018)
First state examination for the teaching degree Realschule Physics (2018)
First state examination for the teaching degree Gymnasium Physics (2018)
First state examination for the teaching degree Mittelschule Physics (2018)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020)
Bachelor's degree (1 major) Aerospace Computer Science (2020)
First state examination for the teaching degree Grundschule Physics (2020)
First state examination for the teaching degree Gymnasium Physics (2020)
First state examination for the teaching degree Realschule Physics (2020)
First state examination for the teaching degree Mittelschule Physics (2020)
Bachelor's degree (1 major) Functional Materials (2021)
Bachelor's degree (1 major) Quantum Technology (2021)
Bachelor's degree (1 major) Mathematics (2023)
exchange program Physics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)
Bachelor's degree (1 major) Functional Materials (2025)

Module title				Abbreviation
Advanced and Computational Data Analysis				11-P-FR2-152-m01
Module coordinator			**Module offered by**	
Managing Director of the Institute of Applied Physics			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
2	(not) successfully completed	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	Students are highly recommended to complete module 11-P-FR1 prior to completing module 11-P-FR2.		

Contents

Advanced methods of data analysis and error calculation. Distribution function, significance tests, modelling. Computerised data analysis.

Intended learning outcomes

The students have advanced knowledge of the analysis of measuring data and error calculation. They have mastered methods of computerised data analysis are able to apply them to self-obtained measuring data and to discuss the results.

Courses (type, number of weekly contact hours, language — if other than German)

V (1) + Ü (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Exercises (successful completion of approx. 50% of approx. 10 exercise sheets)
Assessment offered: Once a year, summer semester

Allocation of places

--

Additional information

--

Workload

60 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Nanostructure Technology (2015)
Bachelor's degree (1 major) Mathematical Physics (2015)
Bachelor's degree (1 major) Mathematical Physics (2016)
Bachelor's degree (1 major) Physics (2020)
Bachelor's degree (1 major) Nanostructure Technology (2020)
Bachelor's degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major) Functional Materials (2021)
Bachelor's degree (1 major) Quantum Technology (2021)
exchange program Physics (2023)
Bachelor's degree (1 major) Mathematical Physics (2024)
Bachelor's degree (1 major) Functional Materials (2025)

Thesis

(10 ECTS credits)

Module title				Abbreviation
Bachelor Thesis Physics				11-BA-P-152-m01
Module coordinator			**Module offered by**	
chairperson of examination committee			Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**		
10	numerical grade	--		
Duration	**Module level**	**Other prerequisites**		
1 semester	undergraduate	--		

Contents

Mostly independent processing of an experimental or theoretical task of Physics according to known procedures and scientific aspects.

Intended learning outcomes

The students are able to independently work on an experimental or theoretical task from Physics, especially according to known methods and scientific aspects and to write the Bachelor's thesis.

Courses (type, number of weekly contact hours, language — if other than German)

No courses assigned to module

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Bachelor's thesis (approx. 25 pages)
Language of assessment: German or English

Allocation of places

--

Additional information

Time to complete: 12 weeks.

Workload

300 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module appears in

Bachelor's degree (1 major) Physics (2015)
Bachelor's degree (1 major) Physics (2020)