

Subdivided Module Catalogue

for the Subject

Physics

with the degree "Erweiterungsprüfung für das Lehramt an
Gymnasien"
(ECTS credits)

Examination regulations version: 2020
Responsible: Faculty of Physics and Astronomy

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:

LASPO2015

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

19-Feb-2020 (2020-21)

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.

The subject is divided into

Abbreviation	Module title	ECTS credits	Method of grading	page
Scientific Discipline (92 ECTS credits)				
Area 1 (92 ECTS credits)				
Foundations of Experimental Physics (23 ECTS credits)				
11-E-M-152-m01	Classical Physics 1 (Mechanics)	8	NUM	8
11-E-E-152-m01	Classical Physics 2 (Heat and Electromagnetism)	8	NUM	6
11-L-OW-172-m01	Optics and Waves	7	NUM	22
Advanced Experimental Physics (23 ECTS credits)				
11-L-M1-172-m01	Modern Physics 1	7	NUM	18
11-L-M2-152-m01	Modern Physics 2 (Molecule and Solid State Physics)	5	NUM	20
11-L-M3-172-m01	Modern Physics 3 (Nuclear, Particle and Astrophysics)	5	NUM	21
11-L-GKP-152-m01	General Concepts of Physics	6	NUM	15
Theoretical Physics (14 ECTS credits)				
11-L-T1-172-m01	Theoretical Physics 1 for Pre Service Teachers	7	NUM	26
11-L-T2F-172-m01	Theoretical Physics 2 for Pre Service Teachers	7	NUM	27
Computational Methods (6 ECTS credits)				
11-M-MR-202-m01	Mathematical Methods of Physics	6	B/NB	32
Laboratory Course I (14 ECTS credits)				
11-P-LA-152-m01	Laboratory Course Physics A(Mechanics, Heat, Electromagnetism)	2	B/NB	35
11-P-FR1-152-m01	Data and Error Analysis	2	B/NB	34
11-P-LB-152-m01	Laboratory Course Physics B (Electricity, Circuits, Atomic and Nuclear Physics)	5	B/NB	36
11-P-LFP-152-m01	Advanced Laboratory Course	5	B/NB	37
Laboratory Course Physics II (12 ECTS credits)				
11-P-DP1-172-m01	Demonstration Laboratory Course 1	5	NUM	33
11-P-LLL-DP2-172-m01	Practical Training in Student Lab / Demonstration Laboratory Course 2	7	NUM	38
Teaching (10 ECTS credits)				
Area 1 (10 ECTS credits)				
11-L-PD-172-m01	Physics Teaching Concepts	5	NUM	24
11-L-PDS-152-m01	Physics Teaching Concepts Seminar	2	B/NB	25
11-L-L3SGY-152-m01	Student Lab Preparation Course (Physics) German Gymnasium	3	NUM	17
Freier Bereich (general as well as subject-specific electives)				
Physics (Freier Bereich (general as well as subject-specific electives) -- subject specific)				
11-L-EL1-152-m01	Teaching Seminar Fundamental Principles	3	B/NB	13
11-L-EL2-152-m01	Selected Topics in Physics Didactics	3	B/NB	14
11-P-VKM-202-m01	MINT Preparatory Course Mathematical Methods of Physics	3	B/NB	39
11-L-L3B-152-m01	Student Lab Supervision (Physics)	2	B/NB	16
11-MIND-Ph1-152-m01	Low Cost - High Impact. Low-budget Experiments for Science Courses (Physics)	2	B/NB	30
11-MIND-Ph2-152-m01	Teaching Science with Hands-on-Exhibits (Physics)	2	B/NB	31
11-AP-152-m01	Astrophysics	6	NUM	5
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11-ENT-152-m01	Principles of Energy Technologies	6	NUM	10
11-L-APD-152-m01	Current Topics of Teaching Concepts in Physics	3	NUM	11
11-L-WPD-152-m01	Scientific Work in Teaching Concepts	3	B/NB	28
11-LX6-152-m01	Current Topics in Physics	6	NUM	29
11-LCS6-152-m01	Selected Topics of Physics	4	NUM	12

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 can be chosen to earn a 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		
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Additional information		
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Workload		
180 h		
Teaching cycle		
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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 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 can be chosen to earn a bonus)

written examination (approx. 120 minutes)

Language of assessment: German and/or English

Allocation of places

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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

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

§ 53 I Nr. 1 a)

§ 77 I Nr. 1 a)

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, slat 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 can be chosen to earn a bonus)
written examination (approx. 120 minutes) Language of assessment: German and/or English
Allocation of places
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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
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 53 I Nr. 1 a) § 77 I Nr. 1 a)

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 can be chosen to earn a 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		
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Additional information		
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Workload		
180 h		
Teaching cycle		
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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 title		Abbreviation
Current Topics of Teaching Concepts in Physics		11-L-APD-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)
3	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
Contents		
Current topics in physics education.		
Intended learning outcomes		
The students have knowledge of a current subdiscipline of physics education and are able to classify the acquired knowledge according to subject-specific contexts and implement it into classes.		
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 can be chosen to earn a bonus)		
a) written examination (approx. 45 minutes) or b) oral examination of one candidate each (approx. 10 minutes) or c) oral examination in groups (groups of 2, approx. 10 minutes per candidate) or d) term paper (approx. 8 pages) or e) talk (30 to 45 minutes) with discussion		
Allocation of places		
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Additional information		
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Workload		
90 h		
Teaching cycle		
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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 title		Abbreviation
Selected Topics of Physics		11-LCS6-152-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)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Approval from examination committee required.
Contents		
Current topics in experimental physics. Credited 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 (1)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a 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		
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Additional information		
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Workload		
120 h		
Teaching cycle		
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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 title		Abbreviation
Teaching Seminar Fundamental Principles		11-L-EL1-152-m01
Module coordinator		Module offered by
holder of the Chair of Physics and its Didactics		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		
Physical and interdisciplinary aspects of selected topics of physics education, corresponding student preconceptions and typical learning difficulties, elementarisation and didactic reconstruction of physical contents based on specific contents of physics education, verbalisation of physical contents, possible teaching methods, typical school experiments and suitable media.		
Intended learning outcomes		
Advanced, qualitative knowledge of school-relevant areas of Physics; knowledge of common methods, typical student preconceptions and special media on relevant topics; awareness of the differences between teaching Physics at university and school regarding contents and methods.		
Courses (type, number of weekly contact hours, language — if other than German)		
S (2)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) term paper (approx. 8 pages) or b) presentation (approx. 45 minutes) or c) written examination (approx. 45 minutes) or d) oral examination of one candidate each (approx. 15 minutes) or e) oral examination in groups (groups of 2, approx. 15 minutes per candidate) Language of assessment: German and/or English		
Allocation of places		
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Additional information		
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Workload		
90 h		
Teaching cycle		
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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 title		Abbreviation
Selected Topics in Physics Didactics		11-L-EL2-152-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)
3	(not) successfully completed	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
Contents		
Current topics in physics education.		
Intended learning outcomes		
The students have knowledge of a current subdiscipline of physics education and are able to classify the acquired knowledge according to subject-specific contexts and implement it into classes.		
Courses (type, number of weekly contact hours, language — if other than German)		
S (2)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) term paper (approx. 8 pages) or b) presentation (approx. 45 minutes) or c) written examination (approx. 45 minutes) or d) oral examination of one candidate each (approx. 15 minutes) or e) oral examination in groups (groups of 2, approx. 15 minutes per candidate) Language of assessment: German and/or English		
Allocation of places		
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Additional information		
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Workload		
90 h		
Teaching cycle		
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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 title		Abbreviation
General Concepts of Physics		11-L-GKP-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		
This module focuses on important concepts and applications that constitute interconnections between the sub-disciplines of Physics (and partly other Natural Sciences). When it comes to concepts, these interconnections are structural, they are elements of the physical terminology and belong to the mental structure of the subject. Applied Physics: synergetic interconnections between elements of knowledge of the corresponding subdiscipline and beyond which are necessary for the solution of many important problems. On both levels, the specific contents and the resulting interconnections have the same significance. Structures and concepts: Dimensional analysis, scaling, similitude theory; fields; interactions; symmetries and conserved quantities, wave equation, waves; multipoles among other mode analysis; non-linear dynamics, self-organisation, deterministic chaos; analogies of transport phenomena; Virial theorem as a structural element; microscopic modelling of macroscopic phenomena; scattering and structure determination; aspects of the history of ideas of important concepts and their controversies (e.g. atomism, determinism); Applied and Technical Physics: Physics and information/communication technology; rules and process technology, sensors; medical technology; climate and weather; Biophysics; ecology; energy; celestial mechanics, satellites, GPS; measuring devices; el. light sources; displays		
Intended learning outcomes		
Their understanding of important shared concepts enables the students to connect different subdisciplines of Physics, they know the similarities and differences of different usage contexts and therefore have in-depth knowledge of these concepts and are able to mathematically describe and process relevant problems on the level of Theoretical Physics; they understand complex systems of nature and engineering and are able to connect their own physical knowledge in a synergetic manner by analysing the solutions to selected, complex problems, they are able to explain the interactions of knowledge of different disciplines for the solution of complex problems on the basis of selected examples.		
Courses (type, number of weekly contact hours, language — if other than German)		
V (2) + Ü (1) + S (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 can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each (approx. 20 minutes) Language of assessment: German and/or English		
Allocation of places		
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Additional information		
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Workload		
180 h		
Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 77 I Nr. 1 b)		

Module title		Abbreviation
Student Lab Supervision (Physics)		11-L-L3B-152-m01
Module coordinator		Module offered by
holder of the Chair of Physics and its Didactics		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		
The module provides an introduction to successful supervision of pupils independently carrying out experiments in the teaching-learning-laboratory.		
Intended learning outcomes		
The students learn to classify different groups of pupils according to their subject-specific and experimental level of performance, to support the pupils according to their needs and age and to help them during independent experimenting (supervision competencies in open classroom situations). The students are able to methodically and critically evaluate their own actions. A lecturer gives individual feedback to the students to avoid negative behaviour patterns and to support the students' strengths. The students develop professional behaviour patterns by repeatedly working on the same topic with different groups of pupils (reflection competencies and self-control competencies).		
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 can be chosen to earn a bonus)		
a) written examination (approx. 45 minutes) or b) oral examination of one candidate each (approx. 10 minutes) or c) oral examination in groups (groups of 2, approx. 10 minutes per candidate) or d) term paper (approx. 8 pages)		
Allocation of places		
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Additional information		
This module is designed for students studying at least one subject in the natural sciences.		
Workload		
60 h		
Teaching cycle		
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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 title		Abbreviation
Student Lab Preparation Course (Physics) German Gymnasium		11-L-L3SGY-152-m01
Module coordinator		Module offered by
holder of the Chair of Physics and its Didactics		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		
The module gives an overview of applicable physical experiments that provide an introduction to science and can be performed in teaching-learning-laboratories (M!ND center). In these experiments, different working methods are employed.		
Intended learning outcomes		
The students know how to prepare and follow-up a visit in a teaching-learning-laboratory (M!ND-Center) and have gained an overview of current didactic research topics and further possibilities for development in the field of subject-didactic research. They are able to evaluate and assess the (affective) learning achievements of pupils, to hold scientific-propaedeutic classes, to positively influence the motivation of pupils in the subject of Physics and to raise their interest for current physical research questions. The students are able to select, set up or build pupils experiments in a target-oriented manner, and to supervise pupils while experimenting.		
Courses (type, number of weekly contact hours, language — if other than German)		
S (2)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 45 minutes) or b) oral examination of one candidate each (approx. 10 minutes) or c) oral examination in groups (groups of 2, approx. 10 minutes per candidate) or d) term paper (approx. 8 pages) Language of assessment: German and/or English		
Allocation of places		
--		
Additional information		
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Workload		
90 h		
Teaching cycle		
--		
Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 77 I Nr. 2		

Module title		Abbreviation
Modern Physics 1		11-L-M1-172-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)
7	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
Contents		
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, magnetic 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, diatomic 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 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.		
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Courses (type, number of weekly contact hours, language — if other than German)
V (3) + Ü (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 can be chosen to earn a bonus)
written examination (approx. 120 minutes) Language of assessment: German and/or English
Allocation of places
--
Additional information
--
Workload
210 h
Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 77 I Nr. 1 b)

Module title		Abbreviation
Modern Physics 2 (Molecule and Solid State Physics)		11-L-M2-152-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
2 semester	undergraduate	--
Contents		
Mechanical, dielectric and magnetic properties of molecules, rotational, vibrational and electronic excitation of molecules, measuring methods, structure of solids, scattering methods, lattice vibrations, thermal properties of insulators.		
Intended learning outcomes		
Understanding of the structure of molecules and chemical bonding, knowledge of experimental methods for the examination of molecules, understanding of the structure of crystalline solids, their modelling as translation-invariant lattices and the consequences.		
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 can be chosen to earn a bonus)		
written examination (approx. 90 to 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)		
§ 77 I Nr. 1 b)		

Module title		Abbreviation
Modern Physics 3 (Nuclear, Particle and Astrophysics)		11-L-M3-172-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
2 semester	undergraduate	--
Contents		
German contents available but not translated yet.		
Kernphysik: experimentelle Methoden, Detektoren, Aufbau des Atomkerns, Radioaktivität, Kernspaltung und Kernfusion, technische und medizinische Anwendungen, Strahlenschutz. Elementarteilchenphysik: Teilchenbeschleuniger, Klassifizierung der Elementarteilchen, fundamentale Wechselwirkungen. Astrophysik: Sternentstehung, Aufbau der Sonne, Kosmologie.		
Intended learning outcomes		
German intended learning outcomes available but not translated yet.		
Die Studierenden besitzen strukturiertes Wissen zu den genannten Begriffen; haben Kenntnis der einschlägigen Kerngedanken und Schlüsselexperimente sowie der Messmethoden und Größenordnungen der zentralen Größen; verfügen über die Fähigkeit zur quantitativen Behandlung einfacher einschlägiger Probleme.		
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 can be chosen to earn a bonus)		
written examination (approx. 90 to 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)		
§ 77 I Nr. 1 b)		

Module title		Abbreviation
Optics and Waves		11-L-OW-172-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)
7	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. 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, polarisation, generation by absorption, birefringence, optical activity (dipole); 3. Geometrical optics: Basic concepts, Fermat's principle, optical path, Gaussian optics, reflection, refraction, plane 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, double slit, Young's experiment, interference pattern (intensity profile), thin layers, 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 diffraction, 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 quantisation, harmonic oscillator), box potential in higher dimensions and degeneracy, formal theory of QM (states, operators, observables).		
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) + 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 can be chosen to earn a bonus)
written examination (approx. 120 minutes) Registration: If a student registers for the seminar 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. Language of assessment: German and/or English
Allocation of places
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Additional information
--
Workload
210 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 title		Abbreviation
Physics Teaching Concepts		11-L-PD-172-m01
Module coordinator		Module offered by
holder of the Chair of Physics and its Didactics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	--
Contents		
Teaching of basic concepts of physics education and didactic consolidation of subject-relevant scientific content of the degree programme. Justification/legitimation of physics teaching; educational objectives of physics as a subject; competence models and educational standards; elementarisation and didactic reconstruction of physics content; methods and media in physics lessons and their use to promote learning; student perceptions and typical learning difficulties in the subject areas of physics relevant to teaching and teaching concepts based on these; dealing with student perceptions; teaching approaches to the structure and cognitive/working methods of the science of physics, including historical development;		
Intended learning outcomes		
Students are familiar with central physics teaching concepts to design target group-orientated physics lessons. They clearly differentiate didactic aspects of physics lessons from scientific and educational aspects. They are familiar with subject-specific student conceptions and their significance for the students' learning process. They critically discuss specific teaching concepts against this background.		
Courses (type, number of weekly contact hours, language — if other than German)		
V (2) + V (2) + Ü (1)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 60 minutes) or b) oral examination of one candidate each (approx. 15 minutes) or c) oral examination in groups (groups of 2, approx. 15 minutes per candidate) or d) term paper (approx. 8 pages) Language of assessment: German and/or English		
Allocation of places		
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Additional information		
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Workload		
150 h		
Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 36 I Nr. 7 § 38 I Nr. 1 § 53 I Nr. 2 § 77 I Nr. 2		

Module title		Abbreviation
Physics Teaching Concepts Seminar		11-L-PDS-152-m01
Module coordinator		Module offered by
holder of the Chair of Physics and its Didactics		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		
Different topics of current subject-didactic research; examples: Interest and physics education, girls in physics education, evaluation, task culture, interdisciplinary classes, language in physics education, effects of subject media and their application for learning support, especially regarding computers, epistemological and working methods, new teaching methods.		
Intended learning outcomes		
Knowledge of selected methods of didactic physical research, evaluation of didactic physical research projects, knowledge of didactic physical literature. Ability to critically evaluate Physics classes in view of different aspects and to discuss different prioritisations and approaches.		
Courses (type, number of weekly contact hours, language — if other than German)		
S (2)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 45 minutes) or b) oral examination of one candidate each (approx. 10 minutes) or c) oral examination in groups (groups of 2, approx. 10 minutes per candidate) or d) term paper (approx. 8 pages) Language of assessment: German and/or English		
Allocation of places		
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Additional information		
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Workload		
60 h		
Teaching cycle		
--		
Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 77 I Nr. 2		

Module title		Abbreviation
Theoretical Physics 1 for Pre Service Teachers		11-L-T1-172-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)
7	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
Contents		
Basic physical laws and elementary methods of theoretical physics. Mechanics: Newton's laws Physical quantities and conservation laws, systems of mass points, reference systems, dimensional motion, Lagrange equations, applications, Hamiltonian dynamics. Quantum Mechanics: Schrödinger equation, one-dimensional quantum mechanics, quantum mechanics Abstract (operator formalism), angular momentum, spin. Electrodynamics: Maxwell equations, electrostatics, magnetostatics, dynamic electromagnetic fields, Special Theory of Relativity. Thermodynamics: Heat, entropy, thermal equilibrium, measured variables, efficiency, Thermodynamic potentials, phase transitions.		
Intended learning outcomes		
Students have an understanding of the fundamental laws of the interrelationships and elementary methods of theoretical physics from the theoretical mechanics, quantum mechanics, thermodynamics, electrodynamics and statistical physics. They can use the acquired theoretical concepts and fit into larger physical context and discuss.		
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 can be chosen to earn a bonus)		
written examination (approx. 120 minutes) Language of assessment: German and/or English creditable for bonus		
Allocation of places		
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Additional information		
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Workload		
210 h		
Teaching cycle		
--		
Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 77 I Nr. 1 c)		

Module title		Abbreviation
Theoretical Physics 2 for Pre Service Teachers		11-L-T2F-172-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)
7	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
Contents		
Statistical Physics, thermodynamics and electrodynamics. Among others: Maxwell equations, electrostatics, magnetostatics, dynamic electromagnetic fields, special theory of relativity; heat, entropy, thermal equilibrium, measured variables, efficiency, thermodynamic potentials, phase transitions		
Intended learning outcomes		
The students know the basic principles, contexts and elementary methods of Theoretical Physics, thermodynamics, electrodynamics and Statistical Physics. They are able to discuss the acquired theoretical concepts and to attribute them to bigger physical contexts. The students are able to independently apply the methods of Theoretical Physics to the solution of problems of thermodynamics, electrodynamics and Statistical Physics and to interpret the solutions.		
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 can be chosen to earn a bonus)		
written examination (approx. 120 minutes) Language of assessment: German and/or English creditable for bonus		
Allocation of places		
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Additional information		
--		
Workload		
210 h		
Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 77 I Nr. 1 c)		

Module title		Abbreviation
Scientific Work in Teaching Concepts		11-L-WPD-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		
Current topics in scientific work in physics education		
Intended learning outcomes		
The students have knowledge of a current subdiscipline of physics education and are able to process questions of physics education on the basis of scientific methods.		
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 can be chosen to earn a bonus)		
talk (30 to 45 minutes)		
Allocation of places		
--		
Additional information		
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Workload		
90 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 title		Abbreviation
Current Topics in Physics		11-LX6-152-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 in physics.		
Intended learning outcomes		
The students have knowledge of a current subdiscipline of Physics and understand the measuring and/or calculation 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 can be chosen to earn a 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		
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Additional information		
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Workload		
180 h		
Teaching cycle		
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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 title		Abbreviation
Low Cost - High Impact. Low-budget Experiments for Science Courses (Physics)		11-MIND-Ph1-152-m01
Module coordinator		Module offered by
holder of the Chair of Physics and its Didactics		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		
Conception and realisation of experimental stations with ordinary and inexpensive consumables for classes of Grundschule and secondary level I.		
Intended learning outcomes		
The students develop simple scientific experimenting stations to use for the transition from primary to secondary level I for small groups from different types of schools. In doing so, they learn to simplify and convey scientific contents relevant to the curriculum in due consideration of the target group.		
Courses (type, number of weekly contact hours, language — if other than German)		
S (2)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 45 minutes) or b) oral examination of one candidate each (approx. 10 minutes) or c) oral examination in groups (groups of 2, approx. 20 minutes) or d) term paper (approx. 8 pages)		
Allocation of places		
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Additional information		
This module is designed for students studying at least one subject in the natural sciences.		
Workload		
60 h		
Teaching cycle		
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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 title		Abbreviation
Teaching Science with Hands-on-Exhibits (Physics)		11-MIND-Ph2-152-m01
Module coordinator		Module offered by
holder of the Chair of Physics and its Didactics		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		
Designing and creating hands-on exhibits for STEM subjects.		
Intended learning outcomes		
The students evaluate the advantages and disadvantages of the hands-on approach for teaching scientific contents in and out of school. They plan and implement an interdisciplinary science exhibition as an example of project-oriented work with pupils of secondary level I and II.		
Courses (type, number of weekly contact hours, language — if other than German)		
S (2)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 45 minutes) or b) oral examination of one candidate each (approx. 10 minutes) or c) oral examination in groups (groups of 2, approx. 20 minutes) or d) term paper (approx. 8 pages)		
Allocation of places		
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Additional information		
This module is designed for students studying at least one subject in the natural sciences.		
Workload		
60 h		
Teaching cycle		
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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 title		Abbreviation
Mathematical Methods of Physics		11-M-MR-202-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		
German contents available but not translated yet.		
Grundlagen der Mathematik und elementare Rechenmethoden jenseits des Schulstoffes, insbesondere zur Einführung und Vorbereitung auf die Module der Theoretischen Physik und der Klassischen bzw. Experimentellen Physik		
Intended learning outcomes		
German intended learning outcomes available but not translated yet.		
Der/Die Studierende verfügt über die Kenntnisse der Grundlagen der Mathematik und der elementaren Rechen-techniken, welche in der Theoretischen Physik und der Experimentellen Physik benötigt werden.		
Courses (type, number of weekly contact hours, language — if other than German)		
V (2) + Ü (2) + V (2) + Ü (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 can be chosen to earn a bonus)		
a) Exercises (successful completion of approx. 50% of approx. 13 exercise sheets) or b) Talk (approx. 15 minutes)		
Allocation of places		
--		
Additional information		
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Workload		
180 h		
Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 53 I Nr. 1 a) § 77 I Nr. 1 a)		

Module title		Abbreviation
Demonstration Laboratory Course 1		11-P-DP1-172-m01
Module coordinator		Module offered by
holder of the Chair of Physics and its Didactics		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		
German contents available but not translated yet.		
Grundlegende Experimente des Physikunterrichts der Primar- bzw. Sekundarstufe I, Gerätekunde schultypischer Geräte, Zielsetzung und didaktisches Potential von Demonstrationsexperimenten, Schülerexperimenten, Freihandexperimenten, Modellexperimenten, etc.; rechnergestütztes Experimentieren; Messwerterfassung, interaktive Bildschirmexperimente, etc.; Präsentation von Experimenten; Sicherheit im Physikunterricht, Präsentationskompetenz.		
Intended learning outcomes		
German intended learning outcomes available but not translated yet.		
Kompetenter Umgang mit handels- und schulüblichen Lehrgeräten und Experimentiermaterialien; Strategien zur systematischen Analyse von Fehlerquellen beim eigenen Experimentieren; Erkennen von Kategorien von Experimenten, ihre Funktion und ihr didaktisches Potential; Erfahrung, Experimente lernziel- und schülerorientiert auszuwählen, aufzubauen und zu präsentieren sowie rechnergestützte Demonstrations- und Schülerexperimente einzusetzen; Sicherheitsvorschriften im Physikunterricht.		
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 can be chosen to earn a bonus)		
a) oral examination of one candidate each (approx. 10 minutes) or b) oral examination in groups (groups of 2, approx. 10 minutes per candidate) Language of assessment: German and/or English		
Allocation of places		
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Additional information		
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Workload		
150 h		
Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 53 I Nr. 1 c) § 77 I Nr. 1 d)		

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 can be chosen to earn a bonus)		
written examination (approx. 120 minutes) Language of assessment: German and/or English		
Allocation of places		
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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		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 53 I Nr. 1 c) § 77 I Nr. 1 d)		

Module title		Abbreviation
Laboratory Course Physics A(Mechanics, Heat, Electromagnetism)		11-P-LA-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	--
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 graphs and drafting of measurement protocols.		
Intended learning outcomes		
The student has knowledge and mastery of physical measuring instruments and experimental techniques. He/She is able to plan experiments independently and to perform well in cooperation with others, and to document the measurement results in a measurement 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 can be chosen to earn a 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		
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Additional information		
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Workload		
60 h		
Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 53 I Nr. 1 c) § 77 I Nr. 1 d)		

Module title		Abbreviation
Laboratory Course Physics B (Electricity, Circuits, Atomic and Nuclear Physics)		11-P-LB-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	(not) successfully completed	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	Students are highly recommended to complete modules 11-P-LA and 11-P-FR1 prior to completing module 11-P-LB.
Contents		
Physical laws of the science of electricity, circuits with electrical components and Atomic and Nuclear Physics.		
Intended learning outcomes		
The students have knowledge and skills of physical measuring instruments and experimental techniques. They are able to independently plan and conduct experiments in cooperation with others, and to document the results in a measurement protocol.		
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 can be chosen to earn a 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		
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Additional information		
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Workload		
150 h		
Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 53 I Nr. 1 b) (3 ECTS credits) and c) (2 ECTS credits) § 53 I Nr. 1 c) § 77 I Nr. 1 d)		

Module title		Abbreviation
Advanced Laboratory Course		11-P-LFP-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	(not) successfully completed	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Students are highly recommended to complete module 11-P-LB prior to completing module 11-P-LFP.
Contents		
Experiments of modern physics (Atom and Molecular Physics, Solid-State Physics, Nuclear Physics).		
Intended learning outcomes		
The students have knowledge of conducting an experiment and of analysing and documenting the experimental results. They have basic knowledge of modern evaluation systems. They have gained insights into the experimental methods of modern Physics.		
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 can be chosen to earn a 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		
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Additional information		
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Workload		
150 h		
Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 77 I Nr. 1 d)		

Module title		Abbreviation
Practical Training in Student Lab / Demonstration Laboratory Course 2		11-P-LLL-DP2-172-m01
Module coordinator		Module offered by
holder of the Chair of Physics and its Didactics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
7	numerical grade	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	--
Contents		
The module gives an overview of applicable physical experiments that provide an introduction to science and can be performed in teaching-learning-laboratories (M!ND center). In these experiments, different working methods are employed. Advanced experiments covering topics of secondary level II physics lessons; advanced equipment knowledge of typical school equipment for use in experiments of higher complexity, e.g. Franck-Hertz experiment, Michelson interferometer; in-depth measurement technology; strategies for optimizing experimental set-ups and for systematic identification of sources of error during experiments; guidelines for presenting experiments; safety guidelines for experimentation in physics lessons.		
Intended learning outcomes		
The students know how to prepare and follow-up a visit in a teaching-learning-laboratory (M!ND-Center) and have gained an overview of current didactic research topics and further possibilities for development in the field of subject-didactic research. They are able to evaluate and assess the (affective) learning achievements of pupils, to hold scientific-propaedeutic classes, to positively influence the motivation of pupils in the subject of Physics and to raise their interest for current physical research questions. The students are able to select, set up or build pupils experiments in a target-oriented manner, and to supervise pupils while experimenting.		
Courses (type, number of weekly contact hours, language — if other than German)		
P (3) + P (4)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) oral examination of one candidate each (approx. 10 minutes) or b) oral examination in groups (groups of 2, approx. 10 minutes per candidate) or c) term paper (6 to 12 pages) or d) portfolio (10 to 15 hours total) Language of assessment: German and/or English		
Allocation of places		
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Additional information		
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Workload		
210 h		
Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 77 I Nr. 1 d)		

Module title		Abbreviation
MINT Preparatory Course Mathematical Methods of Physics		11-P-VKM-202-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)
3	(not) successfully completed	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
Contents		
Mathematical basics and elementary calculus refreshing and extending knowledge from school, especially as an introduction and preparation for the modules of experimental and theoretical physics. 1. Basic geometry and algebra, 2. differential calculus and series, 3. integral calculus, 4. vectors – directional quantities, 5. coordinate systems, 6. complex numbers		
Intended learning outcomes		
Students are in command of knowledge of basic mathematics and possess skills in elementary calculus as required for the successful start into the studies of experimental and theoretical physics.		
Courses (type, number of weekly contact hours, language — if other than German)		
V (1) + Ü (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 can be chosen to earn a 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		
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Additional information		
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Workload		
90 h		
Teaching cycle		
Teaching cycle: every year, winter semester		
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)		