Westfälische Wilhelms-Universität Münster

Department of Physics

Course Program

of the BSc in Physics

- Dekanat des Fachbereichs Physik -
April 2018

INTRODUCTION

The Westfälische Wilhelms-Universität in Münster is located in the cultural center of Westphalia in close vicinity to the Netherlands. The Treaty of Westphalia, signed in Münster in 1648, ended the Thirty Years' War. Münster's townhall therefore was awarded with the European Heritage Label. Nearly 60,000 students live in this beautiful town which is known as Germany's bicycle capital. Its economy is based on the service industry and public administration. Students make up about 20% of city's population, resulting in a lively atmosphere. The Department of Physics warmly welcomes foreign students. They are an important factor in creating an open and colorful academic and social life on campus.

We invite foreign students to participate in courses offered by members of the department. The Department of Physics consists of about 25 independent research groups that cover a broad range of specializations. All courses are open to full time, part time, and exchange students. Moreover, students studying other natural sciences, mathematics or medicine – both at the undergraduate and graduate level – are welcome to participate in them.

As a guideline for the selection of appropriate courses, the following list details the contents of lectures and laboratory courses, which are regularly taught during each academic year. Traditionally, the academic year at German universities is split into two semesters: a Winter Term beginning in October and ending in mid-February, and a Summer Term beginning in April and ending at the end of July. The sequence of courses is largely based on the assumption that students start their studies in the Winter Term of the academic year. In addition to the courses listed here, the department also offers a large number of seminars and special courses with varying subjects. Usually, courses are given in a one or two hours time-slot. Most of them start "c.t." (Latin: cum tempore – with time), which means that they actually start at quarter past the hour. However, "s.t." (Latin: sine tempore – without time) indicates that a course will start punctual. For most of the regularly taught lectures times and rooms are given in the module descriptions below. There, the exact times are given. Note, however, that the times and rooms may be subject to change from one semester to the other and a check in the online course overview of the University for the current semester is recommended.

Courses in the Bachelor program are usually taught in German. It is therefore highly recommended that students have a basic working knowledge of German prior to entering the courses. In the laboratory courses, experiments are normally conducted in groups of two students under the supervision of an instructor. Here, English is accepted as a working language for the course work and the reports. Among the exercise classes belonging to the lectures in "Structure of Matter" and "Quantum Theory and Statistical Physics", there is always at least one given in English. Additionally, for exchange students the possibility to replace a written exam (in German) with an oral exam in English can be offered upon request.

In addition to the services provided by the Department of Physics, general support for foreign students is also provided through central university institutions, including the International Office and the Language Center (Sprachenzentrum).

We look forward to seeing you in Münster.

Tilmann Kuhn

Dean of Studies of the Department of Physics Münster, April 2018

CONTACT

Admissions Requirement and Studies

Studierendensekretariat (Student Admissions Office)
Schlossplatz 2, 48149 Münster, Germany
Admission and enrolment procedures for foreign and stateless applicants:

Uwe Goldstein	Room 64	Phone: +49 (0) 251 / 83-24772
Simone Olbrich	Room 64	Phone: +49 (0) 251 / 83-24770
Olaf Rehwinkel	Room 65	Phone: +49 (0) 251 / 83-22237

Guest students, visiting students, and de-registration of foreign students:

Hubert Flatken	Room 56b	Phone: +49 (0) 251 / 83-22238

e-mail: studierendensekretariat@uni-muenster.de
http://www.uni-muenster.de/studium/en/studierendensekretariat.html

International Office

Schlossplatz 3, 48149 Münster, Germany
e-mail: international.office@uni-muenster.de
http://www.uni-muenster.de/InternationalOffice/en/index.html

Advice for International Students
Astrid Burgbacher
Phone: +49 (0) 251/ 83-22254
e-mail: study@uni-muenster.de
http://www.uni-muenster.de/studieninteressierte/en/index.shtml

Exchange Student Service (ESS)
Verena Ingenleuf
Phone: +49 (0) 251 / 83-22113
e-mail: admin.ess@uni-muenster.de

Die Brücke (Welcome Office) (Wilmergasse 2)
Dana Jacob
Phone: +49 (0) 251 / 83-22228
e-mail: diebruecke@uni-muenster.de
http://www.uni-muenster.de/DieBruecke/en/index.html

Counselling for International Students (Wilmergasse 2, Room 104)
Verena Stenzel
Phone: +49 (0) 251 / 83-21879
e-mail: verena.stenzel@uni-muenster.de
Thu 11:00-13:00

Language Courses

Sprachenzentrum (Language Center of the University of Münster)
Lehrgebiet Deutsch als Fremdsprache (German as a Foreign Language)
Hüfferstrasse 27 III, Room B3.10

48149 Münster, Germany
Phone: +49 (0) 251/83-32108 (Mon-Thu 9:30-13:30, Fr 9:30-12:30)
Fax: +49 (0) 251/83-38349
e-mail: ldafmail@uni-muenster.de
http://spz.uni-muenster.de/ldaf

Accommodation

Studierendenwerk Münster (Student Welfare Organization)
- Wohnraumverwaltung
Bismarckallee 5
48151 Münster, Germany
Tel.: +49 (0) 251 / 83-79553 (Tue and Thu 9-12:00, Thu 13-15:00)
e-mail: wohnen@stw-muenster.de
christiane.herding@stw-muenster.de
Phone: +49 (0) 251 / 83-79646
Fax: +49 (0) 251 / 83-79597
https://www.stw-muenster.de/en/home/

Department of Physics

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International Coordinator
Prof. Dr. Helmut Kohl, Room 323 (3rd floor)
Wilhelm-Klemm-Straße 10
48149 Münster, Germany
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e-mail: kohl@uni-muenster.de

Study Coordinator
Apl. Prof. Dr. Hartmut Bracht, Room 613b (6th floor)
Wilhelm-Klemm-Straße 10
48149 Münster, Germany
Phone: +49 (0) 251 / 83-39004
e-mail: bracht@uni-muenster.de

Prüfungsamt der Math.-Nat. Fakultät (Examination Office)
Orléans-Ring 10
48149 Münster, Germany
Annette Ohnolz-Paschert (responsible for the BSc in physics and geophysics)
Phone: +49 (0) 251 / 83-35007
e-mail: annette.paschert@uni-muenster.de
http://www.uni-muenster.de/MNFak/Pruefungsamt/

Descriptions of the Modules of the Degree Programs

Physics

and

Physics with Specialization “Scientific Instrumentation”

(Bachelor of Science)

Department of Physics
University of Münster

Recommended Study Organization

<table>
<tr><th>Semester</th><th colspan="4">Modules</th></tr>
<tr><td>1 (WS)</td><td>Physics I
14 CP</td><td></td><td rowspan="2">Fundamental Mathematics
16 CP</td><td rowspan="3">Interdisciplinary Studies*
18 CP</td></tr>
<tr><td>2 (SS)</td><td>Physics II
14 CP</td><td></td></tr>
<tr><td>3 (WS)</td><td>Physics III
14 CP</td><td rowspan="2">Laboratory Course I
13 CP</td><td>Integration Theory
8 CP</td></tr>
<tr><td>4 (SS)</td><td>Atomic and Quantum Physics
10 CP</td><td rowspan="2">Computational Physics
9 CP</td><td>Measuring Technology and Signal Processing
8 CP</td></tr>
<tr><td>5 (WS)</td><td>Structure of Matter
14 CP</td><td rowspan="2">Laboratory Course II
13 CP</td><td rowspan="2">Professional Qualification**
16 CP</td></tr>
<tr><td>6 (SS)</td><td></td><td>Bachelor’s Thesis
13 CP</td></tr>
</table>

WS: Winter Semester SS: Summer Semester

* Choice from a list of interdisciplinary modules (see module descriptions) or personal composition of an interdisciplinary module which has a reasonable relation to the study of physics or will be suitable for the professional qualification (to be agreed on with the Dean of Studies).

** Choice of the module “Quantum Theory and Statistical Physics”, leading to the degree *Bachelor of Science in Physics* or the module “Scientific Instrumentation” leading the the degree *Bachelor of Science in Physics with specialization “Scientific Instrumentation”*.

Module Descriptions

Note that the lecture rooms and times given in the following module descriptions may be subject to change. Please check with the online course overview of the University.

Module 1	**Physics I: Dynamics of Particles and Particle Systems**
Semester	1st semester, WS
Person in charge	Dean of Studies
Components (course, duration, CP, term, time)	Physics I (lecture 6 h/w and exercises 4 h/w, 14 CP, WS) *Lecture: Tue 10:30-12:00; Wed 8:15-9:45; Fri 10:30-12:00; IG1 HS1* *Exercises: Mon, Thu 8:30-10:00, various rooms; alternative dates possible*
Credit points/ Work load	14 CP / 420 h (150 h in-class, 270 h self-studies)
Learning targets	Understanding of phenomena and physical processes in nature; mathematical representation and critical reflection of physical laws. Familiarization with the basic concepts of physics: experimentation, mathematical description, numerical modelling and visualization, here applied to mechanical processes. Knowledge of relevant experimental devices and measurement techniques.
Contents	Methodology of Physics: What is physics? The role of theory and experiment; physical quantities and unit systems; measurements and uncertainties; vectors and fields; complex numbers; expansions; differential equations. Dynamics of Particles: Newton's laws; force, momentum and angular momentum; oscillations; work and energy; the concept of fields; conservation laws; principle of relativity; accelerating and rotating reference frames; motion in central force fields. Particle Systems: center of gravity and conservation laws; coupled oscillators; dynamics of rigid bodies; deformable bodies; elasticity theory; dynamics of fluids and gases; kinetic theory of gases; distribution functions; mechanical and acoustic waves; Doppler effect.
Requirements to meet	Successful participation in the exercises to "Physics I".
Exam	3 hours written exam. The two modules with the best grades among the three modules "Physics I", "Physics II" and "Physics III" count to the overall grade of the BSc. If this is to be applied to this module, it counts 11% of the overall grade.
Prerequisites for attending	None

Module 2	**Physics II: Thermodynamics and Electromagnetism**
Semester	2nd semester, SS
Person in charge	Dean of Studies
Components (course, duration, CP, term, time)	Physics II (lecture 6 h/w and exercises 2 h/w, 10 CP, SS) *Lecture: Tue 10:30-12:00; Wed 8:15-9:45; Fri 10:30-12:00; IG1 HS1* *Exercises: Thu 8:30-10:00, various rooms; alternative dates possible* Theoretical Supplement to Physics II (lecture 2 h/w and exercises 1 h/w, 4 CP, SS) *Lecture: Thu 14:15-15:45; AP HS* *Exercises: Mon 8:30-10:00, various rooms; alternative dates possible*
Credit points/ Work load	14 CP / 420 h (165 h in-class, 255 h self-studies)
Learning targets	Understanding of phenomena and physical processes in nature; mathematical representation and critical reflection of physical laws. Familiarization with the basic concepts of physics: experimentation, mathematical description, numerical modelling and visualization, here applied to thermodynamic and electrodynamic processes. Knowledge of relevant experimental devices and measurement techniques. Theoretical supplement: thorough knowledge of the fundamental principles of classical mechanics, familiarization with the methods of analytical mechanics and their application to physical problems, understanding the basics of linear and nonlinear dynamical systems.
Contents	Thermodynamics: temperature and heat; state variables; entropy and its statistical interpretation; the laws of thermodynamics; heat engines; transport phenomena; real gases; state of aggregation; phase transitions. Electric Charges and Currents: basic phenomena; electric fields and potentials; voltage; electric fields in matter and at interfaces (electrostatic induction and dielectricity), DC circuits; electric work and power; conduction phenomena in solids, liquids and gases. Electromagnetism: electric currents and magnetic fields; magnetic fields in matter; types of magnetism; forces acting on current-carrying conductors; induction and induction devices; electromagnetism in vacuum and in matter; Lorentz force; Hall effect; AC resistances and circuits; oscillating circuits. Theoretical Supplement: analytical mechanics and dynamical systems: constraints and generalized coordinates, d'Alembert and Hamilton principle, Lagrangian formulation of mechanics, phase space, Hamiltonian mechanics, canonical transformations, Poisson bracket, basics of linear and nonlinear dynamic systems
Requirements to meet	Successful participation in the exercises to the lectures “Physics II” and “Theoretical Supplement to Physics II”.
Exam	4 hours written exam. The two modules with the best grades among the three modules “Physics I”, “Physics II” and “Physics III” count to the overall grade of the BSc. If this is to be applied to this module, it counts 11% of the overall grade.
Prerequisites for attending	Recommended: Physics I.

Module 3	**Fundamental Mathematics**
Semester	1st (WS) and 2nd (SS) semester
Person in charge	Dean of Studies (Department of Mathematics)
Components (course, duration, CP, term, time)	Mathematics for Physicists I (lecture, 4 h/w, 4 CP, WS) *Mon 10:15-11:45; Thu 10:15-11:45; IG1 HS2* Exercises to Mathematics for Physicists I (2 h/w, 4 CP, WS) *Tue 8:30-10:00, various rooms*, *alternative dates possible* Mathematics for Physicists II (lecture, 4 h/w, 4 CP, SS) *Mon 10:15-11:45; Thu 10:15-11:45; AP HS* Exercises to Mathematics for Physicists II (2 h/w, 4 CP, SS) *Tue 8:30-10:00, various rooms*, *alternative dates possible*
Credit points/ Work load	16 CP / 480 h (180 h in-class, 300 h self-studies)
Learning targets	Understanding the basic concepts of analysis and linear algebra and ability to solve related problems.
Contents	Complete induction, mathematical nomenclature. Vector Spaces: dimension, subspace, linear systems of equations. Convergence of series and progressions, real numbers, euclidean and normed vector spaces, complex numbers, exp and log, roots, powers, trigonometric functions, unitary vector spaces. Differentiable functions of one variable, mean value theorem and applications, curves, differentiable functions of several variables, gradients, vector fields. Integration in one-dimension: antiderivative, Taylor theorem, improper integrals, arc length, line integrals. Series of Functions: different types of convergence, normed vector spaces, topology of metric spaces, interchange of limiting processes Linear Transformations: dimension formula, matrix representation, determinants, volumes, vector product, eigenvalues, normal forms Differentiable Mappings: inverse theorem, implicit functions, Lagrange multipliers
Requirements to meet	Successful participation in the exercises to the lectures “Mathematics for Physicists I” and “Mathematics for Physicists II”. 2 hours written test on “Mathematics for Physicists I”.
Exam	2 – 3 hours written exam on the subjects of “Mathematics for Physicists II”. The module with the best grade among the two modules “Fundamental Mathematics” and “Integration Theory” counts to the overall grade of the BSc. If this is to be applied to this module, it counts 11% of the overall grade.
Prerequisites for attending	None

Module 4	**Physics III: Waves and Quanta**
Semester	3rd semester, WS
Person in charge	Dean of Studies
Components (course, duration, CP, term, time)	Physics III (lecture 6 h/w and exercises 2 h/w, 10 CP, WS) *Lecture: Mon 10:30-12:00; Wed 10:30-12:00; Thu 10:30-12:00; IG1 HS1* *Exercises: Tue 8:30-10:00, various rooms; alternative dates possible* Theoretical Supplement to Physics III (lecture 2 h/w and exercises 1 h/w, 4 CP, WS) *Lecture: Thu: 14:15-15:45; IG1 HS2* *Exercises: Fri 8:30-10:00, various rooms; alternative dates possible*
Credit points/ Work load	14 CP / 420 h (165 h in-class, 255 h self-studies)
Learning targets	Understanding of phenomena and physical processes in nature; mathematical representation and critical reflection of physical laws. Familiarization with the basic concepts of physics: experimentation, mathematical description, numerical modelling and visualization, here applied to optical and quantum mechanical wave phenomena. Knowledge of relevant experimental devices and measurement techniques. Theoretical supplement: understanding of the basic principles of special relativity, application to relativistic problems in mechanics and electrodynamics.
Contents	Electromagnetic Waves: Maxwell's equations, generation of electromagnetic waves, electromagnetic waves in vacuum, in insulators and in conductors; wave propagation; wave packets; phase and group velocity; measurement of the velocity of light; Michelson-Morley experiment. Optics: Interaction of light with matter; polarization and crystal optics; geometrical optics; optical instruments; wave optics; interference and diffraction; near-field and far-field optics; applications of interference and diffraction phenomena; nonlinear optics. Quanta: black body radiation; Planck's law of radiation; photo effect; laser; Compton effect; wave-particle dualism; statistical interpretation of wave functions; uncertainty relation; Franck-Hertz experiment. Theoretical Supplement: principles of special relativity, mathematical formulation, 4-vectors, covariant formulation of mechanics and electrodynamics.
Requirements to meet	Successful participation in the exercises to the lectures "Physics III" and "Theoretical Supplement to Physics III".
Exam	4 hours written exam. The two modules with the best grades among the three modules "Physics I", "Physics II" and "Physics III" count to the overall grade of the BSc. If this is to be applied to this module, it counts 11% of the overall grade.
Prerequisites for attending	Recommended: Physics I, Physics II.

Module 5	**Integration Theory**
Semester	3rd semester, WS
Person in charge	Dean of Studies (Department of Mathematics)
Components (course, duration, CP, term, time)	Mathematics for Physicists III (lecture, 4 h/w, 4 CP, WS) *Tue 10:15-11:45; Fri 10:15-11:45; AP HS* Exercises to Mathematics for Physicists III (2 h/w, 4 CP, WS) *Wed 8:30-10:00, various rooms*, *alternative dates possible*
Credit points/ Work load	8 CP / 240 h (90 h in-class, 150 h self-studies)
Learning targets	Understanding the basic concepts of integration theory and ability to solve related problems.
Contents	Ordinary Differential Equations: Picard-Lindelöf theorem, linear differential equations, examples. Measure and Integration theory: transformation rule, the Lebesgue integral, convergence theorems, theorem of Fubini, Integral theorems of Stokes, Gauß and Green in two and three dimensions. Complex Analysis: Cauchy integral theorem, power series, residue theorem, Fourier series: convergence in the mean. Hilbert space: L^2 and Fourier transformation.
Requirements to meet	Successful participation in the exercises to the lecture “Mathematics for Physicist III”.
Exam	2 – 3 hours written exam on the subjects of “Mathematics for Physicists III”. The module with the best grade among the two modules “Fundamental Mathematics” and “Integration Theory” counts to the overall grade of the BSc. If this is to be applied to this module, it counts 11% of the overall grade.
Prerequisites for attending	Recommended: Fundamental Mathematics.

Module 6	**Laboratory Course I**
Semester	3rd (WS) and 4th (SS) semester
Person in charge	Prof. Dr. M. Donath
Components (course, duration, CP, term, time)	Laboratory Course in Mechanics and Electromagnetism (4 h/w, 7 CP, WS) Laboratory Course in Optics, Thermal und Atomic physics (4 h/w, 6 CP, SS) *Mon, Tue or Thu: 13:00-17:00, various laboratories*
Credit points/ Work load	13 CP / 390 h (120 h laboratory course, 270 h preparation and follow-up work)
Learning targets	Inductive understanding of phenomena and processes in nature; basic comprehension of experimental methods in classical mechanics, thermal physics, electromagnetism, optics and atomic physics. Practical experience in working with experimental setups; ability to interpret the measurements and to write a report
Contents	Selected experiments in classical mechanics, thermal physics, electromagnetism, optics, and atomic physics. Evaluation and documentation of the experiments with common calculation, graphics and text processing programs.
Requirements to meet	Successful completion of all required experiments.
Exam	Preparation, execution and written documentation of all experiments will be evaluated. Based on the evaluation a final grade is issued in each semester. The average of the individual semester grades yields to the overall grade for the module. The grade of the module does *not* contribute to the overall grade of the BSc.
Prerequisites for attending	Recommended: Physics I, Physics II.

Module 7	**Atomic and Quantum Physics**
Semester	4th semester, SS
Person in charge	Dean of Studies
Components (course, duration, CP, term)	Atomic and Quantum Physics (lecture, 6 h/w, 6 CP, SS) *Mon 10:15-11:45; Wed 10:15-11:45; Thu 10:15-11:45; IG1 HS2* Exercises to Atomic and Quantum Physics (2 h/w, 4 CP, SS) *Tue: 8:30-10:00, various rooms; alternative dates possible*
Credit points/ Work load	10 CP / 300 h (120 h in-class, 180 h self-studies)
Learning targets	Basic understanding of quantum mechanics and atomic physics; Ability to mathematically solve problems in quantum mechanics and atomic physics; Advanced knowledge of the quantum nature of matter.
Contents	Introduction to Quantum Mechanics: (corresponding to 4 h/w) Schrödinger equation; wave packets; simple potential problems; harmonic oscillator (eigenvalues and eigenfunctions); hydrogen atom (physics of angular momenta, radial equation, energy spectrum); spin (phenomena and formal description); indistinguishability (Bosons and Fermions) Atomic and Molecular Physics: atomic nature of matter; Stern-Gerlach experiment; experimental methods in atomic physics; models of atoms; hydrogen atom; atoms with more than one electron; atoms in external fields; elementary structure of simple molecules; current topics in atomic and molecular physics
Requirements to meet	Successful participation in the exercises to “Atomic and Quantum Physics”.
Exam	3 hours written exam. The grade of the module counts 7% to the overall grade of the BSc.
Prerequisites for attending	Recommended: Physics I, Physics II, Physics III.

Module 8	**Measuring technology and signal processing**
Semester	4th semester, SS
Person in charge	Prof. Dr. Fallnich, Prof. Dr. Demokritov
Components (course, duration, CP, term, time)	Fundamentals of Signal Processing (lecture 4 h/w and exercises 2 h/w, 8 CP, SS) *Lecture: Tue 10:15-11:45, Fri: 10:15-11:45; AP HS* *Exercises: Thu: 8:30-10:00, various rooms, alternative dates possible*
Credit points/ Work load	8 CP / 240 h (90 h in-class, 150 h self-studies)
Learning targets	Basic knowledge in electronics, optoelectronics, automatic control engineering and communication technology; Practice in analogue and digital standard methods; Analysis of data by use of computers; Comprehension of the interplay between physics and technologies.
Contents	Electronic and optoelectronic components; analog and digital electronic circuits, steering and controlling; data analysis; basics of systems technology (methods in Fourier space); stochastic processes and noise; digital and analog signal processing; correlation procedures; storage and transformation of information; temporal, spatial and spatio-temporal information; linear and nonlinear systems; physical basis of information technology, life science, energy production and environmental studies.
Requirements to meet	Successful participation in the exercises.
Exam	30 – 45 minutes oral exam. The grade of the module counts 7% to the overall grade of the BSc.
Prerequisites for attending	None

Module 9	**Computational Physics**
Semester	4th (SS) and 5th (WS) semester
Person in charge	Prof. Dr. Doltsinis
Components (course, duration, CP, term, time)	Introduction to Scientific Programming (mandatory, lecture 2 h/w and exercises 1 h/w, 5 CP, SS), *Lecture: Thu: 14:15-15:45; IG1 HS2; Exercises: different times and rooms* Numerical Solution of Physical Problems (elective, lecture 2 h/w and exercises 1 h/w, 4 CP, WS) *Lecture: Tue: 14:15-15:45; IG1 HS2; Exercises: different times and rooms* or Computer Based Experimentation (elective, experimental exercises, 4 CP, WS or SS) or Participation in a course of the ZIV equivalent to 4 CP which is to be related to the study of physics (to be agreed on with the person in charge of this module) (elective, 4 CP, WS or SS) or Project in the interdisciplinary course “Nonlinear Modelling in Natural Sciences” (elective, 4 CP, WS or SS)
Credit points/ Work load	9 CP / 270 h (90 h in-class, 180 h self-studies)
Learning targets	Introduction to Scientific Programming: use of computers to solve physical problems, algorithmic formulation of problems, understanding the possibilities and limits of numerical simulations. Numerical Solution of Physical Problems: learning of basic algorithms to solve problems in different parts of physics. Computer based Experimentation: Use of computers to control experiments and to obtain and handle measured data.
Contents	Introduction to Scientific Programming: Introduction to operating systems and programming languages, transformation of physical problems to algorithmic form, number representations, numerical solutions of physical problems, analysis of convergence, numerical differentiation and integration. Numerical Solution of Physical Problems: Systems of linear equations, eigenvalue problems, Fast-Fourier transformation, ordinary and partial differential equations, integral equations, Monte-Carlo methods. Computer Based Experimentation: Computer controlled data acquisition and handling using a convenient language (voice recording, music, noise etc., Fourier analysis including the window function, analogue and digital signal filters, correlation functions, practical application of the sampling theorem). Nonlinear modelling in natural sciences Basics in nonlinear dynamics, theory and modelling of complex systems, scientific programming, interdisciplinary cooperation in small groups.
Requirements to meet	Successful participation in the exercises to “Introduction to scientific programming”. Successful participation in the exercises or practical course to the chosen elective part.
Exam	2 hours written exam on “Introduction to scientific programming”. The grade of the module does *not* contribute to the overall grade of the BSc.
Prerequisites for attending	Recommended: Physics I, Physics II, Physics III.

Module 10	**Structure of Matter**
Semester	5th semester, WS
Person in charge	Dean of Studies
Components (course, duration, CP, term, time)	Physics of Condensed Matter (lecture 4 h/w, 4 CP, WS) *Wed 10:15-11:45, Fri 8:30-10:00; IG1 HS2* Exercises to Physics of Condensed Matter (1 h/w, 2CP, WS) *Wed 9:15-10:00, various rooms* Nuclear and Particle Physics (lecture 3 h/w, 3 CP, WS) *Wed 12:15-13:00, Thu 10:15-11:45; AP HS* Exercises to Nuclear and Particle Physics (1 h/w, 2 CP, WS) *Wed 9:15-10:00, various rooms* Astrophysics and Cosmology (lecture 1 h/w, 1 CP, WS) *Thu 12:15-13:00; IG1 HS2* Seminar (2 h/w, 2 CP, WS or SS) *(choice among various seminars at different times and places)*
Credit points/ Work load	14 CP / 420 h (180 h in-class, 240 h self-studies)
Learning targets	Advanced knowledge of the structure of matter and its exploration, knowledge of the used experimental and mathematic tools, ability to identify and to apply physical concepts like symmetry, ability to become acquainted with a physical topic and to present it orally.
Contents	Physics of Condensed Matter: structure and bonding of solids, methods of structure determination, reciprocal lattice, lattice vibrations (phonons), thermal, magnetic and optical properties of solids, electronic properties of metals and semiconductors, band structure, semiconductor interfaces, superconductivity. Nuclear and Particle Physics: interaction of radiation and matter, particle detectors and particle accelerators, liquid drop and Fermi gas model, scattering and nuclear reactions, gamma and beta decay, nuclear fission, nuclear fusion, nucleosynthesis, symmetries and conservation laws, quantum numbers, static quark model, fundamental interactions. Astrophysics and Cosmology: experimental methods, star formation, Hertzsprung-Russell diagram, neutron stars, black holes, Schwarzschild radius, supernovae, evolution of the universe, background radiation, structure formation, Hubble parameter.
Requirements to meet	Successful participation in the exercises to “Physics of Condensed Matter”. Successful participation in the exercises to “Nuclear and Particle Physics”. Successful participation (including talk/presentation) in the seminar.
Exam	30 – 45 minutes oral exam. The grade of the module counts 12% to the overall grade of the BSc.
Prerequisites for attending	Recommended: Physics I, Physics II, Physics III, Atomic and Quantum Physics.

Module 11	**Laboratory Course II**
Semester	5th (WS) and 6th (SS) semester
Person in charge	Dean of Studies
Components (course, duration, CP, term, time)	Exercises in the Institute of Physics (3 CP,WS SS) Exercises in the Institute of Applied Physics (3 CP, WS, SS) Exercises in the Institute of Nuclear Physics (3 CP, WS, SS) Exercises in the Institute of Materials Physics (4 CP, WS, SS) *Mon 9:00-17:00, various laboratories*
Credit points/ Work load	13 CP/390 h (120 h in-class,270 h self-studies)
Learning targets	Advanced analogue and digital metrological methods and analysis of data using computers, acquisition of practical skills on ambitious experimental set-ups for different topics in experimental physics. Basic knowledge of electronics, optoelectronics, controlling, and information technologies. Advanced knowledge of atomic and solid state physics, devices and measuring methods of atomic and solid state physics. Advanced knowledge of nuclear and particle physics, nuclear-physical devices and measuring methods. Advanced knowledge of functional materials, devices and measuring methods in material physics.
Contents	Selected experiments to learn about measuring techniques and experimental and theoretical aspects of different sections of physics. Ability to experiment with complex measurement techniques and computer based data acquisition and to evaluate the results.
Requirements to meet	Successful completion including lab report of all required experiments
Exam	Preparation, execution and written reports of all experiments will be evaluated. Based on the evaluation a final grade is issued in each of the four parts of the module. The average of the individual grades of the parts yields the overall grade for the module. The grade of the module counts 9% to the overall grade of the BSc.
Prerequisites for attending	Required: Physics I, Physics II and Laboratory Course I Recommended: Physics III, Atomic and Quantum Physics, Measuring technology and signal processing.

Module 12	**Bachelor's thesis**
Semester	6th semester, SS
Person in charge	Supervisor of Bachelor's thesis
Components (course, duration, CP, term)	Independent work on the subject of the bachelor's thesis (12 CP). Preparation and presentation of the results in a final talk (1 CP).
Credit points/ Work load	13 CP / 390 h (in-class and self-studies)
Learning targets	The student demonstrates the ability to deal with a current problem of experimental or theoretical physics using scientific methods within the given timeline, to perfomr thorough literature research on the given topic and to present the results appropriately in written and oral form.
Contents	A topic of research suggested by a supervisor in agreement with the department is dealt with. If supervised by a member of the Department of Physics, the thesis project can be also done as an internship in industry.
Requirements to meet	Preparation of the thesis and final talk on the subject of the thesis (duration 30 minutes). The two examiners of the thesis have to participate in the oral presentation.
Exam	The module grade is the grade of the bachelor's thesis. The grade of the module counts 10% to the overall grade of the BSc.
Prerequisites for attending	To start working for the Bachelor's thesis the successful completion of 90 CP is required.

Module 13	**Professional Qualification: Quantum Theory and Statistical Physics** (elective module)
Semester	5th (WS) and 6th (SS) semester
Person in charge	Dean of Studies
Components (course, duration, CP, term, time)	Quantum Theory (lecture 4 h/w and exercises 2 h/w, 8 CP, WS) *Lecture: Tue 10:15-11:45; Fri 10:15-11:45; IG1, HS2* *Exercises: Thu 14:15-15:45, various rooms; alternative dates possible* Statistical Physics (lecture 4 h/w and exercises 2 h/w, 8 CP, SS) *Lecture: Tue 10:15-11:45; Fri 10:15-11:45; IG1, HS2* *Exercises: Thu 14:15-15:45, various rooms; alternative dates possible*
Credit points/ Work load	16 CP / 480 h (180 h in-class, 300 h self-studies)
Learning targets	Advanced understanding of quantum theory and statistical physics to describe systems on the basis of their fundamental microscopic properties. Advanced knowledge of the mathematical structure of quantum theory and the statistical approach to many-particle systems. Ability to find mathematical solutions to problems in quantum theory and statistical physics.
Contents	Quantum Theory: mathematical framework of quantum theory; symmetries and conservation laws; postulates and measurement process; addition of angular momentum and spin-orbit coupling; approximation methods for time-independent and time-dependent problems, atoms in electric and magnetic fields, Fermi's golden rule; stationary scattering theory; second quantization; quantised radiation field and spontaneous emission; EPR paradox, hidden variables and Bell's inequality. Statistical Physics: fundamentals of probability theory and mathematical statistics; statistical description of many-particle systems; statistical ensembles; relation between statistical physics and phenomenological thermodynamics; entropy and information; thermodynamic potentials; classical ideal gas; ideal quantum gases (Fermi and Bose gas); real gases; magnetic systems and phase transitions; statistics and kinetics of non-equilibrium systems; transport processes.
Requirements to meet	Successful participation in the exercises to "Quantum Theory". Successful participation in the exercises to "Statistical Physics". 3 hours written test on the subject of "Quantum Theory".
Exam	30 – 45 minutes oral exam. The grade of the module counts 10% to the overall grade of the BSc.
Remark	This module is mandatory for a direct entry into the MSc programme in physics in Münster.
Prerequisites for attending	Recommended: Physics I, Physics II, Physics III, Laboratory Course I, Atomic and Quantum Physics.

Module 14	**Professional qualification: Scientific Instrumentation** (elective module)
Semester	5th (WS) and 6th (SS) semester
Person in charge	Dean of Studies
Components (course, duration, CP, term)	6 module parts in four-week block courses: – Electronics (2 CP, 30 h in-class, 30 h self-studies) – Laser and Optical Measurement Techniques (3 CP, 30 h in-class, 60 h self-studies) – Microscopy (3 CP, 30 h in-class, 60 h self-studies) – Spectroscopy and Vacuum Technology (2 CP, 30 h in-class, 30 h self-studies) – Radiation Technology (3 CP, 30 h in-class, 60 h self-studies) – Techniques of Material Physics (3 CP, 30 h in-class, 60 h self-studies)
Credit points/ Work load	16 CP / 480 h (180 h in-class, 300 h self-studies)
Learning targets	Selected examples of modern measuring techniques in the fields of electronics, photonics, microscopy, spectroscopy, vacuum engineering, radiation measuring technique and materials physics. Specific analysis of the methods with regard to measuring quality, measuring limitations and errors. Basic principles of electronic measuring and control technology through practical application of instrumentation hardware and software. Imaging methods: safe and reliable application of laser, optical and fiber-optical elements, vacuum apparatus, radiation sources and detectors.
Contents	Electronics: analysis of components of analogue and digital electronics (diode, transistor, operation amplifier, gate, flip-flops, shift register); cooperation of the components in computer-aided measuring techniques. Laser and Optical Measuring Techniques: properties of laser radiation (coherence, mode structure); analysis of chosen problems of interferometry, holography and speckle measurement technology. Microscopy: modern methods of microscopy: high-resolution (transmission) electron microscopy, atomic force microscopy, scanning tunnelling microscopy. Spectroscopy and Vacuum Technology: modern methods of electron, laser and ion spectroscopy, introduction to pumps and pump systems; methods of vacuum measurement technology. Radiation Technology: physics of ionising radiation, detectors, methods of radioactive dating, medical applications, basics of radiation protection. Techniques of Material Physics: X-ray/neutron diffractometry, X-ray spectroscopy, atom probe tomography, calorimetry, thin-film deposition method, ion beam-assisted preparation techniques in electron microscopy.
Requirements to meet	Successful participation in each of the six parts of the module.
Exam	Preparation, execution and written documentation of all experiments will be evaluated. Based on the evaluation a final grade is issued in each of the six parts of the module. The average of the individual part grades yields the overall grade for the module. The grade of the module counts 10% to the overall grade of the BSc.
remark	By electing this module the final degree is “Bachelor of Science in Physics with Specialization Scientific Instrumentation”. When starting the master’s program in physics the module “Quantum Theory and Statistical Physics” has to be completed in the beginning of that programme. The present module can then be credited as an elective subject of the program.
Prerequisites for attending	Recommended: Physics I, Physics II, Physics III, Measuring Technology and Signal Processing

Module 15a	**Interdisciplinary Studies: Chemistry for Physicists I (Chemistry for Scientists)** (elective module)
Semester	1st (WS) or 3rd (WS) semester
Person in charge	Prof. Dr. Wiemhöfer
Components (course, duration, CP, term)	Chemistry for Scientists (lecture, 4 h/w, 5 CP, WS) Theoretical Exercises in preparation for the Introductory Chemical Laboratory Course (2 h/w, 3 CP, WS) Introductory Chemical Laboratory Course for Scientists (5 h/w, 5 CP, in the lecture-free period)
Credit points/ Work load	13 CP / 390 h (165 h in-class, 225 h self-study)
Learning targets	Fundamental terminology describing important chemical substances and their reactions and quantitative treatment. Relevant inorganic and organic substances and their role in engineering, biosphere and environment as well as their physical-chemical properties. Reactivity and properties of the most important materials in environment and ecological systems, basic competence in evaluation of quantitative chemical data (units of concentration, equilibrium constant). Risk potential of chemical substances, secure working practice in chemistry laboratories, knowledge and competences to obtain chemical data and information. Ability to work autonomously on related chemical problems.
Contents	Lecture and Exercises: Basics in inorganic and organic chemistry. Inorganic Chemistry: atomic structure, chemical bonds (covalent, metallic and ionic bonds), thermal equilibrium, acids and bases, redox reactions, characteristics of selective elements. Organic Chemistry: structure of organic compounds, fundamental types of organic reactions (substitution, addition, elimination). Laboratory Course: Basic rules of working in a chemistry lab, different classes of substances and types of reactions, qualitative analysis (detection reactions).
Requirements to meet	Regular and active participation in exercises and laboratory, Written test on “Chemistry for Scientists”
Exam	90 minutes written exam. The grade of the module counts 8% to the overall grade of the BSc.

Module 15b	**Interdisciplinary Studies: Chemistry for Physicists II (Inorganic Chemistry for Scientists)** (elective module)
Semester	2nd (SS) or 4th (SS) semester
Person in charge	Changing according to the responsibility for the lectures
Components (course, duration, CP, term)	Inorganic Chemistry I (lecture, 3 h/w, 4 CP, SS) Seminar (1 h/w, 1 CP, SS)
Credit points/ Work load	5 CP / 150h (60 h in-class, 90 h self-studies)
Learning targets	On the basis of "Chemistry for Scientists I", the students get an advanced overview of the chemistry of the elements, i.e. discussion of binding characteristics, relationships within the periodic table, with an emphasis on technologically relevant processes.
Contents	Lecture: structural chemistry of the main group elements, fundamentals of chemistry of metals, typical reactions and detection reactions, technically important procedures. Seminar: topics of the lecture, deepening understanding by discussing specific examples.
Requirements to meet	None
Exam	90 minutes written exam. The grade of the module counts 4% to the overall grade of the BSc.
Prerequisites for attending	Successful completion of the written test on "Chemistry for Scientists" in module 15a.

Module 16	**Interdisciplinary Studies: German as a Foreign Language** (elective module)
Semester	1st to 3rd semester
Person in charge	Coordinator of the language center
Components (course, duration, CP, term)	This module can be composed individually out of courses offered by the language center (Sprachenzentrum) in the section “German as a Foreign Language” (“Deutsch als Fremdsprache”). All of these courses must at least have the level of B2. One of them needs the level C1. The Credit Points (CPs) have to sum up to a total of 18 CP. The choice of courses has to be approved by the person in charge of the module.
Credit points/ Work load	18 CP / 540 h
Learning targets	Ability to deal with study-oriented communication situations. The oral and written skills include a science and technically oriented language. The succesful completion of this modules corresponds to a language level of at least B2.
Contents	Depending on the individual composition of the module.
Requirements to meet	Regular attendance in the courses, because language competence is transferred through mutual communication.
Exam	There will be an examination in each of the courses. Examinations can take place in form of an oral or written exam, in form of a homework or an oral presentation. Each grade is weighted according to the number of CPs of the corresponding course. The grade of the module counts 12% to the overall grade of the BSc.
Prerequisites for attending	Only for foreign student with a language competence in German of level DSH-1 (C-Test, at least 46 points). If this level is not reached at the entrance test, the students have to take part in preparatory language courses.

Module 17	**Interdisciplinary Studies: Introduction to Business Administration** (elective module)
Semester	1st to 3rd semester
Person in charge	Prof. Dr. A. Pfingsten, Prof. Dr. W. Berens
Components (course, duration, CP, term)	Business Administration I: Introduction to Business Administration (lecture, 2 h/w, 2 CP) Financing (lecture, 2 h/w, 3 CP) Investment (lecture, 3 h/w, 3 CP) Tutorial on Business Administration I (1 h/w, 1 CP) Business Administration II: Accounting and Annual Financial Statement (lecture, 2 h/w, 3 CP) Fundamentals of Accounting (lecture 3 h/w, 4 CP) Tutorial on Fundamentals of Accounting (exercises, 1 h/w, 2 CP)
Credit points/ Work load	18 CP / 540 h (195 h in-class, 345 h self-studies)
Learning targets	Understanding and application of fundamental economic terms, assigning problems to proper context, development of simple means of problem solving, solving problems in investment and finance.
Contents	Business Administration I: Overview of basic subjects and methods of business administration as well as of functional divisions of companies; special focus on investment and finance decisions including finance mathematical tools. Business Administration II: Basics in accounting.
Exam	2 hours written exam on the subjects of “Introduction to Business Administration", “Financing”and “Investment”. 2 hours written exam on the subjects of “Accounting and Annual Financial Statement” and “Foundations of Accounting”. Each of the two exams counts 50% to the overall grade of the module. The grade of the module counts 12% to the overall grade of the BSc.

Module 18	**Interdisciplinary Studies: Introduction to computer science** (elective module)
Semester	1st and 2nd semester or later (beginning WS)
Person in charge	Prof. Dr. A. Clausing, Prof. Dr. K. Hinrichs
Components (course, duration, CP, term, time)	Computer Science I (lecture, 4 h/w, 5 CP, WS) Exercises to “Computer Science I” (2 h/w, 4 CP, WS) Computer Science II (lecture, 4 h/w, 5 CP, SS) Exercises to “Computer Science II” (2 h/w, 4 CP, WS)
Credit points/ Work load	18 CP / 540 h (210 h in-class, 330 h self-studies)
Learning targets	Abstraction and formalization mechanisms used in computer science. Development of programs in higher level computer languages. Creation of algorithms and data structures; implementation and analysis. (concerning the consumption of resources).
Contents	Overview of computer science, introduction to fundamental terms and ways of thinking in computer science, introduction to a functional and an object-orientated computer language, representation, structure and interpretation of calculations, systems and their descriptions, abstract data types and data structures, creation and analysis of algorithms, fundamental terms of calculability, searching and sorting, schedule structures, trees and graphs, address calculation methods.
Requirements to meet	Successful participation in the “Exercises to Computer Science I and II”.
Exam	2 hours written exam in Computer Science I. 2 hours written exam in Computer Science II. Each of the two exams counts 50% to the overall grade of the module. The grade of the module counts 12% to the overall grade of the BSc.
Prerequisites for attending	None

Module 19	**Interdisciplinary Studies: Introduction to Economics** (elective module)
Semester	1st to 3rd semester
Person in charge	Prof. Dr. Bohl, Prof. Dr. Ströbele, Prof. Dr. van Suntum
Components (course, duration, CP, term)	Macroeconomics I (lecture, 4 h/w, 6 CP) Tutorial on Macroeconomics I (exercises, 2 h/w, 3 CP) Microeconomics I (lecture, 4 h/w, 6 CP) Tutorial on Microeconomics I (exercises, 2 h/w, 3 CP)
Credit points/ Work load	18 CP / 540 h (180 h in-class, 360 h self-studies)
Learning targets	Basic concepts of economics; understanding and applying essential theories and models; assessing states, trends and economic interventions. Independently solving problems in economics.
Contents	Macroeconomics I: The fundamental macroeconomic concepts for a national economy are described and explained. The basis is the national account system. This is followed by a theoretical and an empirically supported analysis of the relationships of the goods, financial and labor markets, through which the concept and structure of the business cycle is explained. On this basis, the causes and effects of important economic phenomena, such as unemployment, are examined, and the prospects and limits of economic measures are identified. Microeconomics I: The course “Microeconomics” deals with the theory of the household on the one hand (optimal household behavior, demand for goods, factor supply, insurance and uncertainty) and with the theory of the firm on the other hand (theory of production, least cost combination, supply of goods, factor demand). Moreover, theorems of welfare economics and incomplete markets are discussed. The aim of the exercises is to deepen the theoretical understanding acquired in the course by providing problem sets that are solved by the students.
Exam	1 hour written exam in “Macroeconomics". 1 hour written exam in “Microeconomics”. Each of the two exams counts 50% to the overall grade of the module. The grade of the module counts 12% to the overall grade of the BSc.

Module 20	**Interdisciplinary Studies: Geophysics** (elective module)
Semester	1st to 3rd semester
Person in charge	Prof. Dr. U. Hansen, Prof. Dr. C. Thomas
Components (course, duration, CP, term, time)	Introduction to Geophysics (lecture, 2 h/w, 2 CP, WS), Exercises to Introduction to Geophysics (1 h/w, 2 CP, WS) Fundamentals of Geophysics I (lecture, 2 h/w, 2 CP, SS), Exercises to Fundamentals of Geophysics I (1 h/w, 2 CP, SS) Geophysics for Advanced Students I (lecture, 2h/w, 2 CP, WS) Exercises to Geophysics for Advanced Students I (1 h/w, 3 CP, WS) Fundamentals of Geophysics II (lecture, 2 h/w, 2 CP, WS) Exercises to Fundamentals of Geophysics II (1 h/w, 3 CP, WS)
Credit points/ Work load	18 CP / 540 h (210 h in-class, 330 h self-study)
Learning targets	Overview of the geophysical approach and the most important methods including simple practical demonstrations and exercises. First steps in data analysis.
Contents	Important components of the system Earth, development, present properties, and relevant processes; seismology and seismological methods for investigations of the inner structure of the Earth; basic principles of the seismic investigation methods; gravitational field and gravimetry, magnetic field and magnetics as well as electric and electromagnetic methods for investigations of the Earth.
Requirements to meet	Successful participation in the exercises.
Exam	4 hours written exam. The grade of the module counts 12% to the overall grade of the BSc.
Prerequisites for attending	None

Module 21	**Interdisciplinary Studies: Philosophy for Physicists** (elective module)
Semester	1st - 3rd semester
Person in charge	Supervisors of the modules M (Metaphysics and Epistemology) and A (Applied Philosophy) of the Bachelor's program in philosophy
Components (course, duration, CP, term, time)	M1: Metaphysics (lecture, 2 h/w, 3 CP, SS) M2: Epistemology (lecture, 2h/w, 3 CP, WS) W1: Philosophy of Science (lecture/seminar, 2h/w, 3 CP) W2: Philosophy of Science (seminar, 2 h/w, 5 CP) Choice of two of the following seminars: M3: Metaphysics/ Epistemology (seminar, 2 h/w, 2 CP, no exam) M4: Metaphysics/ Epistemology (seminar, 2 h/w, 2 CP, no exam) W3: Philosophy of Science (seminar, 2 h/w, 2 CP, no exam) W4: Philosophy of Science (seminar, 2 h/w, 2 CP, no exam)
Credit points/ Work load	18 CP / 540 h (180 h in-class, 350 h self-studies)
Learning targets	After having studied the elective module "Philosophy for Physicists" students shall be able to discern issues and problems of Theoretical Philosophy with respect to their content and formal structure. They will have learnt to analyse and classify philosophical arguments and to examine their validity and soundness. In particular, oral and written presentation skills are practiced. In order to achieve these educational objectives, basic knowledge and proficiency of formal logic and theory of argumentation will be imparted.
Contents	The lectures provide an introduction to metaphysics, epistemology and philosophy of science. In the seminars students have a focus on certain main points of these subjects. The students learn about theoretical and conceptual foundations of the subjects with emphasis on the philosophy of science. The students learn to deal with philosophical problems in a sound and analytically precise way. With the aid of this, a deepened understanding of the limits and capability of our cognition and of the foundations of science shall be reached.
Requirements to meet	Written test of 45 minutes OR 10 minutes oral exam OR essay of 5-6 pages in each of the three parts M1, M2, W1. The type will be determined by the examiner.
Exam	Thesis, essay (15 pages) OR oral exam (15 minutes). The type of the exam will be determined by the examiner. The grade of the module counts 12% to the overall grade of the BSc.
Prerequisites for attending	None

Module 22	**Interdisciplinary Studies: Spanish for Scientists** (elective module)
Semester	1st to 3rd semester
Person in charge	Coordinator of the language center, Ms. Solsona
Components (course, duration, CP, term)	Technical and scientific Language: level B1/B2 OR level B2/C1 (3 CP, 2 h/w, SS, mandatory) Depending on the prior knowledge choice of courses among the following list with a total ol 15 CP. **Level A1/B1:** Spanish without Prior Knowledge 1+2, level A1 (4 h/w, 5 CP, WS/SS) Spanish with Prior Knowledge1+2, level A2 (4 h/w, 5 CP, WS/SS) Español para avanzados 1+2, level B1, compact course in February (4 h/w, 5 CP) **Level B1/B2:** Voces y acentos, level B1/B2 (focus: listening comprehension) (2 h/w, 3 CP, WS/SS) Palabras y textos, level B1/B2 (focus: reading comprehension) (2 h/w, 3 CP, WS/SS) Mesa redonda, level B1/B2 (oral expression) (2 h/2, 3 CP, WS/SS) Taller de escritura, level B1/B2 (focus: written expression) (2 h/w, 3 CP, WS/SS) Learning of Technical Language in a Tandem (2 h/w, 3 CP) Estudiar en España (2 h/w, 3 CP, SS) **Level B2/C1:** Taller de redacción (focus: written expression) (2 h/w, 3 CP, WS/SS) Debatir en español (focus: oral expression / listening comprehension) (2 h/w, 3 CP, WS/SS) Tu turno: ejercicios para la presentación oral (focus: deepening of the competence of presentation) (2 h/w, 3 CP, WS/SS) Learning of Technical Language in a Tandem (2 h/w, 3 CP) Diversidad hispana B2/C1 (Hispanic Cultural Studies) (2 h/w, 3 CP, WS/SS) Competencia Intercultural B2/C1 (Intercultural Competence) (2 h/w, 3 CP, WS/SS)
Credit points/ Work load	18 CP / 540 h
Learning targets	Ability to deal with study-oriented communication situations. The oral and written skills include a science and technically oriented language. The succesful completion of this modules corresponds to a language level of at least B1.

Contents	1. Conversations and discussions on social and basic study-related topics. 2. Reading of everyday-life texts and basic science-related texts with help of reading strategies. 3. Reading of everyday-life texts and advanced science-related texts. 4. Reading and discussion of authentic science-related texts from different areas of sciences. Treatment of intercultural, specialized topics. 5. Learning of technical language in a tandem with the aim to create a project (suitable for the subject). 6. Course for Spanish conversation, level B2. 7. Economic topics of the Spanish culture area. 8. Training for oral and written use of language.
Exam	90 minutes written exam. The grade of the module counts 12% to the overall grade of the BSc.
Prerequisites for attending	Sufficient grade in the entry-level test.

Module 23	**Interdisciplinary Studies: Theoretical Basics of Psychology** (elective module)
Semester	1st to 3rd semester
Person in charge	Dr. C. Dirksmeier
Components (course, duration, CP, term, time)	1. Biological Psychology (lecture, 2 h/w, 6 CP, WS) 2. General psychology and cognitive neuroscience I (lecture, 2 h/w, 4 CP, SS) 3. General psychology and cognitive neuroscience II (lecture, 2 h/w, 4 CP, WS) 4. Choice of one lecture from the following parts of psychology: Differential Psychology, Development Psychology or Social Psychology (lecture/seminar, 2 h/w, 4 CP, WS or SS)
Credit points/ Work load	18 CP / 540 h
Learning targets	The students obtain basic knowledge of biological conditions of behaviour and basic knowledge of theories, experimental methods and research outcomes of general psychology and cognitive neuroscience. They learn the most important methods of biopsychology, general psychology and cognitive neuroscience and are able to classify their possibilities and limits. Furthermore they obtain basic knowledge of methodical and theoretical concepts in one of the following parts: differential psychology, development psychology or social psychology.
Contents	This module introduces the central concepts, research methods and -outcomes of biopsychology, general psychology and cognitive neuroscience. Therefore, the lecture of biospychology is dedicated to basics of general neurophysiology, physiology of senses and behaviour relevant structures of the nerve system. Building up on this, the following lecture is dedicated to electrophysiologic and image-guided methods of biopsychology and the biological basics of different integrative functions of the nerve system are imparted. Contents of the lectures general psychology and cognitive neuroscience are the psychological structures and processes which establish a connection between absorbing information and behaviour (perception, converting, storing and production). Priority is given to structures and processes which are common among all human beings. The elective parts refer to the basics, functions, concepts and research methods of differential psychology, development psychology and social psychology.
Exam	90 minutes written exam or 30 minutes oral exam on each of the three lectures 1.-3. The exam on 1. counts 40%, those on 2. and 3. count 30% each to the final grade of the modue. The grade of the module counts 12% to the overall grade of the BSc.
Prerequisites for attending	After consultation with the person in charge for this module.

Module 24	**Interdisciplinary Studies: Mathematics** (elective module)
Semester	1st to 3rd semester
Person in charge	Dean of Studies and a teaching person of choice
Components (course, duration, CP, term, time)	In agreement with the person in charge for the module and the Dean of Studies of the Department of Physics courses from the “Bachelor of Science in Mathematics” have to be chosen. These have to have a meaningful connection to the studies in physics. The courses “Analysis I”, “Analysis II” and “Linear Algebra I” as well as the accompanying exercises cannot be part of this module. If the module “Basics of Analysis” and the lecture “Linear Algebra I” as well as the “Exercises to Linear Algebra I” and the written examination for “Linear Algebra I” are already completed at the department of mathematics, it is possible to use them to replace the modules “Fundamental Mathematics” (module 3) and “Integration Theory” (module 5). In this case the lecture “Linear Algebra II” and the “Exercises to Linear Algebra II” of the department of mathematics have to be part of the module 24, “Mathematics”.
Credit points/ Work load	18 CP / 540 h
Learning targets	The students get a deep insight in subjects of mathematics, linked to the theoretical description of physical systems. They are able to apply the learned mathematical concepts, methods and connections to the solution of theoretical problems.
Contents	To be agreed on with the person in charge.
Exam	To be agreed on with the person in charge. If two or more exams are passed, the grade of the module will be given by the average of each part's grade weighted according to the respective CPs. The grade of the module counts 12% to the overall grade of the BSc..
Prerequisites for attending	None

Module 25	**Interdisciplinary Studies** (elective module, general description)
Semester	1st to 3rd semester
Person in charge	Chosen by the student, to be agreed on with the Dean of Studies.
Components (course, duration, CP, term)	In agreement with person in charge for the module and the Dean of Studies of the Department of Physics. At least 10 CP must be achieved in courses from a Department other than the Department of Physics. With the exception of English there is also the possibility to intensively learn a foreign language as a subject of the module. If there are no CPs specified for the selected coures, CPs will be calculated according to the following scheme: – Lecture (1 h/w corresponds to 1 CP) – Exercises to lecture (1 h/w corresponds to 2 CP) – Experimental exercises/laboratory (1 h/w corresponds to 1.5 CP) – Seminars (1 h/w corresponds to 1 CP)
Credit points/ Work load	18 CP / 540 h
Conditions	To be agreed on with the person in charge.
Learning targets	To be agreed on with the person in charge.
Contents	To be agreed on with the person in charge.
Study/Exam achievements	To be agreed on with the person in charge. At least one study achievements must be completed. At least one exam. If two or more exams are passed, the grade of the module will be given by the average of each part's grade. The grade of the module counts 12% to the overall grade of the BSc.
Prerequisites for attending	None