Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Subdivided Module Catalogue

for the Subject

# Nanostructure Technology

as a Bachelor's with 1 major

with the degree "Bachelor of Science"

(180 ECTS credits)

Examination regulations version: 2012
Responsible: Faculty of Physics and Astronomy

# Course of Studies - Contents and Objectives

The goal of the studies is it to mediate knowledge on the most important subsections of the Nanostructure Technology and to make the students familiar with the methods of engineering scientific and physical thinking and working. By training of analytic thinking abilities the students acquire the ability to deal later with the various fields of applications and to compile the basic knowledge in particular necessary for a consecutive Bachelor and Master course of studies. Therefore the main emphasis is put on the understanding of the fundamental physical and chemical terms and laws as well as on basic engineering-scientific knowledge and the development of the typical scientific thinking and working structures. During the Bachelor thesis the student should work on an thematic and temporally limited experimental or theoretical engineering-scientific task in the field of Nanostructure Technology using well-known procedures and scientific criteria under guidance to a large extent independently.

# 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:

**ASPO2009**

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

**28-Nov-2012 (2012-184) except for mandatory electives added in Fast Track procedure at a later time**

**04-Nov-2014 (2014-72)**

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 |
|---|---|---|---|---|
| **Compulsory Courses (92 ECTS credits)** | | | | |
| **Nanostructure Technology (NP) (10 ECTS credits)** | | | | |
| 11-EIN-092-m01 | Introduction to Nanoscience | 6 | NUM | 74 |
| 11-HSN-122-m01 | Advanced Seminar Nanostructure Technology | 4 | NUM | 85 |
| **Chemistry (CH) (10 ECTS credits)** | | | | |
| 08-CP1-102-m01 | General Chemistry for Physics and Engineers | 10 | NUM | 27 |
| **Experimental Physics (EX) (32 ECTS credits)** | | | | |
| 11-KP-092-m01 | Classical Physics (Mechanics, Thermodynamics, Waves, Oscillations, Electricity, Magnetism and Optics) | 16 | NUM | 91 |
| 11-KM-092-m01 | Condensed Matter (Quanta, Atoms, Molecules, Solid State Physics) | 16 | NUM | 89 |
| **Lab Course Physics (PP) (13 ECTS credits)**<br>Modules in this area will not factor into the overall grade of the Bachelor's degree. | | | | |
| 11-P-PA-112-m01 | Lab Course A | 5 | B/NB | 113 |
| 11-P-NB-122-m01 | Laboratory Course Nanostructure Technology B | 4 | B/NB | 111 |
| 11-P-NC-122-m01 | Advanced Laboratory Course Nanostructure Technology C | 4 | B/NB | 112 |
| **Mathematics (M) (24 ECTS credits)** | | | | |
| 10-M-NST12-092-m01 | Mathematics 1 and 2 for students in Nanostructure Technology | 16 | NUM | 45 |
| 11-MPI3-062-m01 | Mathematics 3 for students of Physics and Engineering | 8 | NUM | 97 |
| **Theoretical Physics (TP) (16 ECTS credits)**<br>Students interested in participating in the FOKUS programme must take modules 11-TQM-F-2, 11-STE-1 and 11-QSN-P. Module component 11-TQM-F-2, which will prepare students for studying in the Master's programme FOKUS, will be offered in the form of a block course between the lecture periods of the winter and summer semesters (for students who took up studies in winter semester, block course will be offered between third and fourth subject semester). | | | | |
| 11-TP-N-122-m01 | Theoretical Physics for Students of Nanostructure Technology | 16 | NUM | 135 |
| **Compulsory Electives (30 ECTS credits)**<br>Students interested in participating in the FOKUS programme must take modules 11-TM and 11-ED in the sub-area Theoretische Physik (Theoretical Physics). | | | | |
| **Nanostructure Technology** | | | | |
| 11-A2-092-m01 | Electronics | 6 | NUM | 51 |
| 11-SPD-102-m01 | Semiconductor Physics and Devices | 6 | NUM | 124 |
| 11-HLF-092-m01 | Semiconductor Lasers - Principles and Current Research | 6 | NUM | 79 |
| 11-HNS-092-m01 | Semiconductor Nanostructures | 6 | NUM | 83 |
| 11-QTH-102-m01 | Quantum Transport in Semiconductor Nanostructures | 6 | NUM | 119 |
| 11-NAN-092-m01 | Nanoanalytics | 6 | NUM | 102 |
| 11-IEM-111-m01 | Introduction to Electron Microscopy | 4 | NUM | 86 |
| 11-SPI-102-m01 | Spintronics | 6 | NUM | 126 |
| 11-BXN5-112-m01 | Current Topics in Nanostructure Technology | 5 | NUM | 66 |
| 11-BXN6-112-m01 | Current Topics in Nanostructure Technology | 6 | NUM | 67 |
| 11-BXN8-112-m01 | Current Topics in Nanostructure Technology | 8 | NUM | 68 |
| 11-BXP5-112-m01 | Current Topics in Physics | 5 | NUM | 69 |
| 11-BXP6-112-m01 | Current Topics in Physics | 6 | NUM | 70 |
| 11-BXP8-112-m01 | Current Topics in Physics | 8 | NUM | 71 |
| **Energy and Material Science Research** | | | | |
| 11-ENT-092-m01 | Principles of Energy Technologies | 6 | NUM | 75 |

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|---|---|---|---|---|
| 11-NTE-092-m01 | Nanotechnology in Energy Research | 4 | NUM | 104 |
| 11-TDO-092-m01 | Thermodynamics and Economics | 6 | NUM | 128 |
| 11-TMS-102-m01 | Introduction to Functional Materials | 5 | NUM | 134 |
| 11-BVG-092-m01 | Coating Technologies based on Vapour Deposition | 5 | NUM | 64 |
| 11-ZMB-112-m01 | Methods for non-destructive Characterization of Materials and Components | 4 | NUM | 139 |
| 11-ZDR-111-m01 | Principles of two- and threedimensional Röntgen imaging | 6 | NUM | 137 |
| 11-ASL-092-m01 | Applied Superconduction | 6 | NUM | 55 |
| 08-EEW-122-m01 | Electrochemical Energy Storage and Conversion | 5 | NUM | 32 |
| 08-CT-122-m01 | Molecular Materials (Lecture and practical course) | 10 | NUM | 29 |
| 08-CTO-122-m01 | Molecular Materials for Students of Nanostructure Technology | 5 | NUM | 31 |
| 08-NT-122-m01 | Chemically and bio-inspired Nanotechnology for Material Synthesis | 5 | NUM | 37 |
| 08-PCM3-102-m01 | Nanoscale Materials | 5 | NUM | 39 |
| 08-FS1-122-m01 | Material Science 1 (basic introduction) | 5 | NUM | 33 |
| 08-FS2-122-m01 | Material Science 2 (the material groups) | 5 | NUM | 34 |
| 08-FS5-101-m01 | Chemical Nanotechnology: Analytics and Applications | 5 | NUM | 35 |
| 11-BXN5-112-m01 | Current Topics in Nanostructure Technology | 5 | NUM | 66 |
| 11-BXN6-112-m01 | Current Topics in Nanostructure Technology | 6 | NUM | 67 |
| 11-BXN8-112-m01 | Current Topics in Nanostructure Technology | 8 | NUM | 68 |
| 11-TDOE-141-m01 | Thermodynamics and Economics | 3 | B/NB | 130 |
| 11-BSV-122-m01 | Image and Signal Processing in Physics | 6 | NUM | 60 |
| 11-BXP5-112-m01 | Current Topics in Physics | 5 | NUM | 69 |
| 11-BXP6-112-m01 | Current Topics in Physics | 6 | NUM | 70 |
| 11-BXP8-112-m01 | Current Topics in Physics | 8 | NUM | 71 |
| 11-BSV-131-m01 | Image and Signal Processing in Physics | 6 | NUM | 62 |
| 11-PMM-132-m01 | Physics of Advanced Materials | 6 | NUM | 108 |
| **Life Science** | | | | |
| 11-BMT-092-m01 | Biophysical Measurement Technology in Medical Science | 6 | NUM | 58 |
| 11-LMB-092-m01 | Laboratory and Measurement Technology in Biophysics | 6 | NUM | 93 |
| 03-NS-FBM-102-m01 | Functional Biomaterials for Students of Nanostructure Technology and Science | 5 | NUM | 8 |
| 07-4BFMZ5N-102-m01 | Biotechnology 1 for Nanostructure Technology | 5 | NUM | 10 |
| 07-4BFPS2N-102-m01 | Membrane Biology for advanced students for Nanostructure Technology | 5 | NUM | 12 |
| 07-4S1MZ4N-102-m01 | Methods in Biotechnology for Nanostructure Technology | 5 | NUM | 15 |
| 07-4S1MZ5N-102-m01 | Molecular Biotechnology for Nanostructure Technology | 5 | NUM | 17 |
| 07-BTNST-102-m01 | Basics in Biotechnology | 2 | NUM | 23 |
| 07-4S1MZ6-102-m01 | Special Bioinformatics 1 | 5 | NUM | 19 |
| 07-4S1MZ1-102-m01 | Basics in Light- and Electron-Microscopy | 5 | NUM | 13 |
| 07-5S2MZ4-102-m01 | Specific Biotechnology 2 | 10 | NUM | 21 |
| 08-BC-092-m01 | Biochemistry | 6 | NUM | 25 |
| 08-BC-LAGY-092-m01 | Biochemistry (teaching degree for secondary schools) | 3 | NUM | 26 |
| 11-BXN5-112-m01 | Current Topics in Nanostructure Technology | 5 | NUM | 66 |
| 11-BXN6-112-m01 | Current Topics in Nanostructure Technology | 6 | NUM | 67 |
| 11-BXN8-112-m01 | Current Topics in Nanostructure Technology | 8 | NUM | 68 |

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|---|---|---|---|---|
| 11-BXP5-112-m01 | Current Topics in Physics | 5 | NUM | 69 |
| 11-BXP6-112-m01 | Current Topics in Physics | 6 | NUM | 70 |
| 11-BXP8-112-m01 | Current Topics in Physics | 8 | NUM | 71 |
| **Experimental Physics** | | | | |
| 11-PKS-092-m01 | Physics of Complex Systems | 6 | NUM | 106 |
| 11-MSS-102-m01 | Methods in Surface Spectroscopy | 4 | NUM | 100 |
| 11-FKS-092-m01 | Solid State Spectroscopy | 6 | NUM | 77 |
| 11-HLP-092-m01 | Semiconductor Physics | 6 | NUM | 81 |
| 11-MAG-092-m01 | Magnetism | 6 | NUM | 95 |
| 11-BXN5-112-m01 | Current Topics in Nanostructure Technology | 5 | NUM | 66 |
| 11-BXN6-112-m01 | Current Topics in Nanostructure Technology | 6 | NUM | 67 |
| 11-BXN8-112-m01 | Current Topics in Nanostructure Technology | 8 | NUM | 68 |
| 11-BXP5-112-m01 | Current Topics in Physics | 5 | NUM | 69 |
| 11-BXP6-112-m01 | Current Topics in Physics | 6 | NUM | 70 |
| 11-BXP8-112-m01 | Current Topics in Physics | 8 | NUM | 71 |
| **Theoretical Physics** | | | | |
| 11-TM-092-m01 | Theoretical Mechanics | 8 | NUM | 132 |
| 11-ED-092-m01 | Theoretical Electrodynamics | 8 | NUM | 72 |
| 11-QM2-092-m01 | Quantum Mechanics II | 8 | NUM | 117 |
| 11-BXN5-112-m01 | Current Topics in Nanostructure Technology | 5 | NUM | 66 |
| 11-BXN6-112-m01 | Current Topics in Nanostructure Technology | 6 | NUM | 67 |
| 11-BXN8-112-m01 | Current Topics in Nanostructure Technology | 8 | NUM | 68 |
| 11-BXP5-112-m01 | Current Topics in Physics | 5 | NUM | 69 |
| 11-BXP6-112-m01 | Current Topics in Physics | 6 | NUM | 70 |
| 11-BXP8-112-m01 | Current Topics in Physics | 8 | NUM | 71 |
| **Technical Lab Course and Computer-aided Methods** | | | | |
| 11-A2-092-m01 | Electronics | 6 | NUM | 51 |
| 11-PPT-092-m01 | Practical Course Physical Technology of Material Synthesis | 5 | B/NB | 115 |
| 11-A1-092-m01 | Computational Physics | 6 | NUM | 49 |
| 11-A3-072-m01 | Laboratory and Measurement Technology | 6 | NUM | 53 |
| 10-M-NUW-122-m01 | Numerical Mathematics 1 for Economathematics | 10 | NUM | 47 |
| 10-M-PRG-122-m01 | Programming course for students of Mathematics and other subjects | 3 | B/NB | 48 |
| 10-I-EIN-111-m01 | Introduction to Computer Science for Students of all Faculties | 10 | NUM | 40 |
| 10-M-COM-122-m01 | Computational Mathematics | 4 | B/NB | 41 |
| 10-M-MWR-122-m01 | Modelling and Computational Science | 10 | NUM | 43 |
| 11-MPI4-062-m01 | Mathematics 4 for Students of Physics and Engineering | 8 | NUM | 99 |
| 11-BXN6-112-m01 | Current Topics in Nanostructure Technology | 6 | NUM | 67 |
| 11-BXN5-112-m01 | Current Topics in Nanostructure Technology | 5 | NUM | 66 |
| 11-BXN8-112-m01 | Current Topics in Nanostructure Technology | 8 | NUM | 68 |
| 11-BXP5-112-m01 | Current Topics in Physics | 5 | NUM | 69 |
| 11-BXP6-112-m01 | Current Topics in Physics | 6 | NUM | 70 |
| 11-BXP8-112-m01 | Current Topics in Physics | 8 | NUM | 71 |
| 11-SDC-131-m01 | Statistics, Data Analysis and Computer Physics | 4 | NUM | 123 |
| 11-SDC-092-m01 | Statistics, Data Analysis and Computer Physics | 4 | NUM | 121 |
| **Thesis (20 ECTS credits)** | | | | |

The grade awarded for the thesis will count double in the calculation of the overall grade of the Bachelor's degree.

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|---|---|---|---|---|
| 11-BA-N-072-m01 | Bachelor Thesis Nanostructure Technology | 10 | NUM | 57 |
| **Subject-specific Key Skills (16 ECTS credits)** | | | | |
| 11-P-MR-092-m01 | Mathematical Methods of Physics | 6 | B/NB | 109 |
| 11-IP-092-m01 | Industrial Practical Course Nanostructure Technology | 10 | NUM | 88 |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Functional Biomaterials for Students of Nanostructure Technology and Science** | | | 03-NS-FBM-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Functional Materials in Medicine and Dentistry | | Faculty of Medicine | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Fundamental principles and specific knowledge for working in natural and engineering sciences in the field of biomaterials with surface modification and characterisation.

**Intended learning outcomes**

Students have developed an advanced knowledge in at least one application area or technology focus of engineering work, with a particular focus on biomedical materials.

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

This module comprises 2 module components. Information on courses will be listed separately for each module component.

- 03-NS-FBM-1-102: V (no information on SWS (weekly contact hours) and course language available)
- 03-NS-FBM-2-102: V + P (no information on SWS (weekly contact hours) and course language available)

**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)

Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 03-NS-FBM-1-102:** Functional Biomaterials for Students of Nanostructure Technology and Science

- 3 ECTS, Method of grading: numerical grade
- written examination (approx. 90 to 120 minutes) or oral examination of one candidate each or oral examination in groups (approx. 30 minutes)

**Assessment in module component 03-NS-FBM-2-102:** Special Topics in Functional Biomaterials Special Topics in Functional Biomaterials

- 2 ECTS, Method of grading: (not) successfully completed
- placement report / fieldwork report / report on practical training / report on practical course / project report / report on technical course (approx. 10 to 20 pages)

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)

Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Biotechnology 1 for Nanostructure Technology** | | | 07-4BFMZ5N-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Biotechnology | | Faculty of Biology | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | By way of exception, additional prerequisites are listed in the section on assessments. | |

**Contents**

During this practical course, students will acquire an insight into a variety of topics in biotechnology.

**Intended learning outcomes**

Students are able to apply advanced methods in biotechnology.

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

This module comprises 2 module components. Information on courses will be listed separately for each module component.

- 07-4BFMZ5N-1-102: P (no information on SWS (weekly contact hours) and course language available)
- 07-4BFMZ5N-2-102: S (no information on SWS (weekly contact hours) and course language available)

**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)

Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 07-4BFMZ5N-1-102:** Biotechnology 1 Laboratory Practice for Nanostructure Technology

- 4 ECTS, Method of grading: numerical grade
- placement report / fieldwork report / report on practical training / report on practical course / project report / report on technical course (approx. 10 to 20 pages)
- Assessment offered: once a year, summer semester
- Other prerequisites: Admission prerequisite to assessment: regular attendance of placement.

**Assessment in module component 07-4BFMZ5N-2-102:** Biotechnology 1 Seminar für Nanostructure Technology

- 1 ECTS, Method of grading: (not) successfully completed
- presentation/seminar presentation (approx. 20 to 30 minutes)
- Assessment offered: once a year, summer semester

**Allocation of places**

Number of places: 2. Should the number of applications exceed the number of available places, places will be allocated by lot. Should there be, within one module component, several courses with a restricted number of places, there will be a uniform regulation for the courses of one module component. In this case, places on all courses of a module component that are concerned will be allocated in a standardised procedure. When places are allocated by lot, applicants who already have successfully completed at least one other module component of the respective module will be given preferential consideration. A waiting list will be maintained and places reallocated as they become available.

**Additional information**

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**Workload**

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**Teaching cycle**

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| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Membrane Biology for advanced students for Nanostructure Technology** | | | 07-4BFPS2N-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Plant Physiology and Biophysics | | Faculty of Biology | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Admission prerequisite to assessment: regular attendance of exercises as well as successful completion of the respective exercises. | |

**Contents**

In this module, students will acquire the general fundamentals of plant membrane transport and the biophysical methods with which it can be characterised. For this purpose, students will be introduced to modern methods of molecular biology and imaging as well as data collection and analysis.

**Intended learning outcomes**

Students understand basic membrane transport processes and are able to use experimental methods in experiments with intact plants, isolated plant cells as well as animal expression systems.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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) log (approx. 10 to 20 pages) or c) oral examination of one candidate each (approx. 30 minutes) or d) oral examination in groups of up to 3 candidates (approx. 60 minutes) or e) presentation (approx. 20 to 30 minutes)

**Allocation of places**

Number of places: 2. Should the number of applications exceed the number of available places, places will be allocated by lot. Should there be, within one module component, several courses with a restricted number of places, there will be a uniform regulation for the courses of one module component. In this case, places on all courses of a module component that are concerned will be allocated in a standardised procedure. When places are allocated by lot, applicants who already have successfully completed at least one other module component of the respective module will be given preferential consideration. A waiting list will be maintained and places reallocated as they become available.

**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Basics in Light- and Electron-Microscopy** | | | 07-4S1MZ1-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| head of the Department of Electronmicroscopy | | Faculty of Biology | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Admission prerequisite to assessment: regular attendance of exercises and successful completion of the respective exercises as specified at the beginning of the course. | |

**Contents**

Fundamental principles of confocal laser scanning microscopy and electron microscopy.

**Intended learning outcomes**

Students have acquired theoretical knowledge and practical skills in the area of light and electron microscopy.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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. 30 to 60 minutes)

**Allocation of places**

Number of places: 18. Should the number of applications exceed the number of available places, places will be allocated as follows: Places will primarily be allocated to students of the Bachelor's degree subject Biologie (Biology) with 180 ECTS credits. Should the module be used in other subjects, there will be two quotas: 95% of places will be allocated to students of the Bachelor's degree subject Biologie (Biology) with 180 ECTS credits and 5% of places (a minimum of one participant in total) will be allocated to students of the Bachelor's degree subject Biologie (Biology) with 60 ECTS credits and to students of the Bachelor's degree subjects Computational Mathematics and Mathematik (Mathematics), each with 180 ECTS credits, as part of the application-oriented subject Biology (as well as potentially to students of other 'importing' subjects). Should the number of places available in one quota exceed the number of applications, the remaining places will be allocated to applicants from the other quota. Should there be, within one module component, several courses with a restricted number of places, there will be a uniform regulation for the courses of one module component. In this case, places on all courses of a module component that are concerned will be allocated in a standardised procedure. In this procedure, applicants who already have successfully completed at least one other module component of the respective module will be given preferential consideration. A waiting list will be maintained and places re-allocated as they become available. Selection process group 1 (95%): Places will primarily be allocated according to the applicants' previous academic achievements. For this purpose, applicants will be ranked according to the number of ECTS credits they have achieved and their average grade of all assessments taken during their studies or of all module components in the subject of Biologie (Biology) (excluding Chemie (Chemistry), Physik (Physics), Mathematik (Mathematics)) at the time of application. This will be done as follows: First, applicants will be ranked, firstly, according to their average grade weighted according to the number of ECTS credits (qualitative ranking) and, secondly, according to their total number of ECTS credits achieved (quantitative ranking). The applicants' position in a third ranking will be calculated as the sum of these two rankings, and places will be allocated according to this third ranking. Among applicants with the same ranking, places will be allocated according to the qualitative ranking or otherwise by lot. Selection process group 2 (5%): Places will be allocated according to the following quotas: Quota 1 (50% of places): total number of ECTS credits already achieved in modules/module components of the Faculty of Biology; among applicants with the same number of ECTS credits achieved, places will be allocated by lot. Quota 2 (25% of places): number of subject semesters of the respective applicant; among applicants with the same number of subject semesters, places will be allocated by lot. Quota 3 (25% of places): allocation by lot. Should the module be used only in the Bachelor's degree subject Biologie (Biology) with 180 ECTS credits, places will be allocated according to the selection process of group 1.

| **Additional information** |
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| **Workload** |
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| **Teaching cycle** |
| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Biology (2011)<br>Bachelor' degree (1 major) Biology (2010)<br>Bachelor' degree (1 major) Mathematics (2012)<br>Bachelor' degree (1 major) Mathematics (2013)<br>Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Bachelor' degree (1 major) Computational Mathematics (2012)<br>Bachelor' degree (1 major) Computational Mathematics (2013)<br>Bachelor's degree (1 major, 1 minor) Biology (Minor, 2010) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Methods in Biotechnology for Nanostructure Technology** | | | 07-4S1MZ4N-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Biotechnology | | Faculty of Biology | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

This module will provide students with an overview of instrument-based methods in biotechnology and biomedicine. In particular, imaging methods as well as single-cell technologies will be discussed. Publications on the methodology of biotechnology will be analysed.

**Intended learning outcomes**

Students are able to select the instrument-based method in biotechnology and biomedicine that is appropriate to a particular problem.

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

This module comprises 2 module components. Information on courses will be listed separately for each module component.

- 07-4S1MZ4N-1-102: V (no information on SWS (weekly contact hours) and course language available)
- 07-4S1MZ4N-2-102: S (no information on SWS (weekly contact hours) and course language available)

**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)

Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 07-4S1MZ4N-1-102:** Methods in Biotechnology for Nanostructure Technology

- 3 ECTS, Method of grading: numerical grade
- written examination (approx. 20 minutes)

**Assessment in module component 07-4S1MZ4N-2-102:** Seminar Methods in Biotechnology for Nanostructure Technology

- 2 ECTS, Method of grading: (not) successfully completed
- presentation/seminar presentation (approx. 15 to 20 minutes)
- Assessment offered: once a year, summer semester

**Allocation of places**

Number of places: 2. Should the number of applications exceed the number of available places, places will be allocated by lot. Should there be, within one module component, several courses with a restricted number of places, there will be a uniform regulation for the courses of one module component. In this case, places on all courses of a module component that are concerned will be allocated in a standardised procedure. When places are allocated by lot, applicants who already have successfully completed at least one other module component of the respective module will be given preferential consideration. A waiting list will be maintained and places reallocated as they become available.

**Additional information**

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**Workload**

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**Teaching cycle**

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| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| --- |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Molecular Biotechnology for Nanostructure Technology** | | | 07-4S1MZ5N-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Biotechnology | | Faculty of Biology | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Theoretical aspects of modern molecular biotechnology.

**Intended learning outcomes**

Students have acquired knowledge and skills in the area of molecular biotechnology.

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

This module comprises 2 module components. Information on courses will be listed separately for each module component.

- 07-4S1MZ5N-1-102: V (no information on SWS (weekly contact hours) and course language available)
- 07-4S1MZ5N-2-102: S (no information on SWS (weekly contact hours) and course language available)

**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)

Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 07-4S1MZ5N-1-102:** Aspects of Modern Biotechnology for Nanostructure Technology

- 3 ECTS, Method of grading: numerical grade
- written examination (approx. 30 minutes)

**Assessment in module component 07-4S1MZ5N-2-102:** Seminar Modern Biotechnology for Nanostructure Technology

- 2 ECTS, Method of grading: (not) successfully completed
- presentation/seminar presentation (approx. 15 to 20 minutes)
- Assessment offered: once a year, summer semester

**Allocation of places**

Number of places: 2. Should the number of applications exceed the number of available places, places will be allocated by lot. Should there be, within one module component, several courses with a restricted number of places, there will be a uniform regulation for the courses of one module component. In this case, places on all courses of a module component that are concerned will be allocated in a standardised procedure. When places are allocated by lot, applicants who already have successfully completed at least one other module component of the respective module will be given preferential consideration. A waiting list will be maintained and places reallocated as they become available.

**Additional information**

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**Workload**

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**Teaching cycle**

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

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| **Module appears in** |
| --- |
| Bachelor' degree (1 major) Nanostructure Technology (2010) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Special Bioinformatics 1** | | | 07-4S1MZ6-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Bioinformatics | | Faculty of Biology | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Admission prerequisite to assessment: regular attendance of exercises and successful completion of the respective exercises as specified at the beginning of the course. | |

**Contents**

Fundamental principles of the tree of life, fundamental principles of phylogenetics (methods and markers), fundamental principles of evolutionary biology (concepts), sequence analysis, RNA structure prediction, phylogenetic reconstruction.

**Intended learning outcomes**

Students are able to use software and databases for sequence analysis, RNA structure prediction and phylogenetic reconstruction.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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)

log (approx. 10 to 20 pages)
Language of assessment: German or English

**Allocation of places**

Number of places: 20. Should the number of applications exceed the number of available places, places will be allocated as follows: Places will primarily be allocated to students of the Bachelor's degree subject Biologie (Biology) with 180 ECTS credits. Should the module be used in other subjects, there will be two quotas: 95% of places will be allocated to students of the Bachelor's degree subject Biologie (Biology) with 180 ECTS credits and 5% of places (a minimum of one participant in total) will be allocated to students of the Bachelor's degree subject Biologie (Biology) with 60 ECTS credits and to students of the Bachelor's degree subjects Computational Mathematics and Mathematik (Mathematics), each with 180 ECTS credits, as part of the application-oriented subject Biology (as well as potentially to students of other 'importing' subjects). Should the number of places available in one quota exceed the number of applications, the remaining places will be allocated to applicants from the other quota. Should there be, within one module component, several courses with a restricted number of places, there will be a uniform regulation for the courses of one module component. In this case, places on all courses of a module component that are concerned will be allocated in a standardised procedure. In this procedure, applicants who already have successfully completed at least one other module component of the respective module will be given preferential consideration. A waiting list will be maintained and places re-allocated as they become available. Selection process group 1 (95%): Places will primarily be allocated according to the applicants' previous academic achievements. For this purpose, applicants will be ranked according to the number of ECTS credits they have achieved and their average grade of all assessments taken during their studies or of all module components in the subject of Biologie (Biology) (excluding Chemie (Chemistry), Physik (Physics), Mathematik (Mathematics)) at the time of application. This will be done as follows: First, applicants will be ranked, firstly, according to their average grade weighted according to the number of ECTS credits (qualitative ranking) and, secondly, according to their total number of ECTS credits achieved (quantitative ranking). The applicants' position in a third ranking will be calculated as the sum of these two rankings, and places will be allocated according to this third ranking. Among applicants with the same ranking, places will be allocated according to the qualitative ranking or otherwise by lot. Selection process group 2 (5%): Places will be allocated according to the following quotas: Quota 1 (50% of places): total number of ECTS credits already achieved in modules/module components of the Faculty of Biology; among applicants with the same number of ECTS credits achieved, places will be allocated by lot. Quota 2 (25% of places): number of subject semesters of the respective applicant;

among applicants with the same number of subject semesters, places will be allocated by lot. Quota 3 (25% of places): allocation by lot. Should the module be used only in the Bachelor's degree subject Biologie (Biology) with 180 ECTS credits, places will be allocated according to the selection process of group 1.

**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Biology (2011)
Bachelor' degree (1 major) Biology (2010)
Bachelor' degree (1 major) Mathematics (2012)
Bachelor' degree (1 major) Mathematics (2013)
Bachelor' degree (1 major) Physics (2010)
Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Computational Mathematics (2012)
Bachelor' degree (1 major) Computational Mathematics (2013)
Bachelor's degree (1 major, 1 minor) Biology (Minor, 2010)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Specific Biotechnology 2** | | | 07-5S2MZ4-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Biotechnology and Biophysics | | Faculty of Biology | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 10 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Admission prerequisite to assessment: regular attendance of exercises and seminar as well as successful completion of the respective exercises as specified at the beginning of the course. | |

**Contents**

This practical course provides students with an insight into different biotechnological and biophysical topics. Under expert guidance, students will perform selected experiments on the following topics: cellular and molecular biotechnology, nano and microsystems biotechnology, biomaterials and biosensors, high-resolution fluorescence microscopy, fluorescence spectroscopy, analysis and electromanipulation of cells.

**Intended learning outcomes**

Students will have acquired a knowledge of fundamental biotechnological and biophysical methods and their applications that will enable them to independently review relevant literature. In addition, they will have become acquainted with - or, where necessary, will be able to independently acquaint themselves with - biophysical mechanisms. Students will have acquired practical experience performing experiments, using a variety of scientific tools. In the seminar, students will have acquired detailed theoretical knowledge on these experiments and will have delivered a short presentation (15 minutes) on one of the experiments they performed.

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

Ü + S (no information on SWS (weekly contact hours) and course language available)

**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)

methods of assessment: a) written examination (approx. 45 to 60 minutes) or b) log (approx. 10 to 20 pages) or c) oral examination of one candidate each (approx. 30 minutes) or d) oral examination in groups of up to 3 candidates (approx. 20 minutes per candidate) or e) presentation (approx. 20 to 30 minutes); students will be informed about the method and length of the assessment prior to the course

**Allocation of places**

Number of places: 18. Should the number of applications exceed the number of available places, places will be allocated as follows: Places will primarily be allocated to students of the Bachelor's degree subject Biologie (Biology) with 180 ECTS credits. Should the module be used in other subjects, there will be two quotas: 95% of places will be allocated to students of the Bachelor's degree subject Biologie (Biology) with 180 ECTS credits and 5% of places (a minimum of one participant in total) will be allocated to students of the Bachelor's degree subject Biologie (Biology) with 60 ECTS credits and to students of the Bachelor's degree subjects Computational Mathematics and Mathematik (Mathematics), each with 180 ECTS credits, as part of the application-oriented subject Biology (as well as potentially to students of other 'importing' subjects). Should the number of places available in one quota exceed the number of applications, the remaining places will be allocated to applicants from the other quota. Should there be, within one module component, several courses with a restricted number of places, there will be a uniform regulation for the courses of one module component. In this case, places on all courses of a module component that are concerned will be allocated in a standardised procedure. In this procedure, applicants who already have successfully completed at least one other module component of the respective module will be given preferential consideration. A waiting list will be maintained and places re-allocated as they become available. Selection process group 1 (95%): Places will primarily be allocated according to the applicants' previous academic achievements. For this purpose, applicants will be ranked according to the number of ECTS credits they have achieved and their average grade of all assessments taken during their studies or of all module components in the subject of Biologie (Biology) (excluding Chemie (Chemistry), Physik (Physics), Mathematik (Mathematics)) at the time of application. This will be done as follows: First, applicants will be ranked, firstly, according to their average grade weighted according to the number of ECTS credits (qualitative ranking)

and, secondly, according to their total number of ECTS credits achieved (quantitative ranking). The applicants' position in a third ranking will be calculated as the sum of these two rankings, and places will be allocated according to this third ranking. Among applicants with the same ranking, places will be allocated according to the qualitative ranking or otherwise by lot. Selection process group 2 (5%): Places will be allocated according to the following quotas: Quota 1 (50% of places): total number of ECTS credits already achieved in modules/module components of the Faculty of Biology; among applicants with the same number of ECTS credits achieved, places will be allocated by lot. Quota 2 (25% of places): number of subject semesters of the respective applicant; among applicants with the same number of subject semesters, places will be allocated by lot. Quota 3 (25% of places): allocation by lot. Should the module be used only in the Bachelor's degree subject Biologie (Biology) with 180 ECTS credits, places will be allocated according to the selection process of group 1.

**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Biology (2011)
Bachelor' degree (1 major) Biology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Basics in Biotechnology** | | | 07-BTNST-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Biotechnology | | Faculty of Biology | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 2 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | According to Section 22 Subsection 8 ASPO (general academic and examination regulations), written examinations can consist entirely or partly of multiple choice questions. If the selected method of assessment includes multiple choice questions, students will have to be informed about this in due time. A minimum of two examiners will compile the set of questions and answers in accordance with Section 16 Subsection 1 ASPO (general academic and examination regulations). They will also determine which answers are to be considered correct. The part of the examination consisting of multiple choice questions will be considered successfully completed if a) a total of a minimum of 60% of the questions asked was answered correctly or if b) a minimum of 50% of questions was answered correctly and the number of questions answered correctly by the examination candidate is no more than 15% lower than the average number of questions answered correctly by students that took the respective examination for the first time. Examination candidates that have correctly answered the minimum number of questions required for successful completion of the examination as specified in sentence 5 will be awarded, in the part of the examination consisting of multiple choice questions, the grade sehr gut (excellent) if they have correctly answered a minimum of 75%, the grade gut (good) if they have correctly answered a minimum of 50% but less than 75%, the grade befriedigend (satisfactory) if they have correctly answered a minimum of 25% but less than 50%, the grade ausreichend (sufficient) if they have correctly answered less than 25% of the rest of the questions asked. When students are informed about the results of the examination, the number of correctly answered questions that was required for successful completion of the examination, the number of questions asked and the average number of questions answered correctly by the reference group mentioned under b) must be communicated to them via the University's notice boards or in another appropriate manner. | |

**Contents**

This module will provide students with an overview of topics in biotechnology: biosensors and environmental biotechnology, microbiotechnology and nanobiotechnology, biomaterials, cryobiotechnology, bioprocess engineering and microbial biotechnology.

**Intended learning outcomes**

Students have become familiar with the fundamental principles of biotechnology.

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

V + S (no information on SWS (weekly contact hours) and course language available)

| **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. 30 minutes) |
| **Allocation of places** |
| -- |
| **Additional information** |
| -- |
| **Workload** |
| -- |
| **Teaching cycle** |
| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Biochemistry** | | | 08-BC-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Biochemistry | | Chair of Biochemistry | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 6 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 2 semester | undergraduate | Admission prerequisite to assessment: successful completion of exercises in the respective classes as specified at the beginning of the course (usually 70% of exercises to be successfully completed) as well as regular attendance of exercises (usually a maximum of 2 incidents of unexcused absence). | |

**Contents**

Comprising lectures and exercises, this module acquaints students with the fundamental principles of biochemistry.

**Intended learning outcomes**

Students have become familiar with the fundamental principles of biochemistry. They are able to describe the key biochemical processes in cellular systems.

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

V + Ü + V + Ü (no information on SWS (weekly contact hours) and course language available)

**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) 1 to 3 written examinations (1 written examination: approx. 90 minutes; 2 written examinations: approx. 60 or 90 minutes each; 3 written examinations: approx. 60 minutes each) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Chemistry (2010)
Bachelor' degree (1 major) Chemistry (2009)
Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) FOKUS Chemistry (2011)
Master's degree (1 major) Chemistry (2010)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Biochemistry (teaching degree for secondary schools)** | | | 08-BC-LAGY-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Biochemistry | | Chair of Biochemistry | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 3 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Admission prerequisite to assessment: successful completion of exercises in the respective classes as specified at the beginning of the course (usually 70% of exercises to be successfully completed) as well as regular attendance of exercises (usually a maximum of 2 incidents of unexcused absence). | |

**Contents**

Comprising lectures and exercises, this module acquaints students with the fundamental principles of biochemistry.

**Intended learning outcomes**

Students have become familiar with the fundamental principles of biochemistry. They are able to describe the key biochemical processes in cellular systems.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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) 1 to 3 written examinations (1 written examination: approx. 90 minutes; 2 written examinations: approx. 60 or 90 minutes each; 3 written examinations: approx. 60 minutes each) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German or English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

§ 62 (1) 2. Chemie "Organische und Bioorganische Chemie"

**Module appears in**

Bachelor' degree (1 major) Physics (2010)
Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
First state examination for the teaching degree Gymnasium Chemistry (2009)

| Module title | | | Abbreviation |
|---|---|---|---|
| **General Chemistry for Physics and Engineers** | | | 08-CP1-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| lecturer of the course | | Institute of Inorganic Chemistry | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 10 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

This module discusses the fundamental principles of both inorganic and organic chemistry. The lab course gives students the opportunity to learn essential methods and perform simple experiments.

**Intended learning outcomes**

Students are able to explain the principles of the periodic table and to extract information from it. They are able to explain basic models of the structure of matter. They have developed the ability to use the language of chemical formulas to describe chemical reactions and to interpret them by identifying the type of reaction. They are able to identify fundamental problems in chemistry and perform experiments to solve them.

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

This module comprises 3 module components. Information on courses will be listed separately for each module component.

- 08-IOC-1-072: V (no information on SWS (weekly contact hours) and course language available)
- 08-CP1-3-072: P (no information on SWS (weekly contact hours) and course language available)
- 08-CP1-1-102: V (no information on SWS (weekly contact hours) and course language available)

**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)

Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 08-IOC-1-072:** Organic Chemistry for students of medicine, biomedicine, dental medicine, engineering and natural science

- 3 ECTS, Method of grading: numerical grade
- written examination (approx. 60 minutes)

**Assessment in module component 08-CP1-3-072:** General and Analytical Chemistry (lab)

- 2 ECTS, Method of grading: (not) successfully completed
- for each experiment: Vortestate (pre-experiment exams, approx. 10 minutes each), assessment of practical performance (log, 2 to 5 pages), Nachtestate (post-experiment exams, approx. 10 minutes each)
- Assessment offered: once a year, summer semester
- Only after successful completion of module components: Successful completion of module component 08-CP1-1 is a prerequisite for participation in module component 08-CP1-3.

**Assessment in module component 08-CP1-1-102:** Principles of Inorganic Chemistry for Physics and Engineering Majors

- 5 ECTS, Method of grading: numerical grade
- written examination (approx. 90 minutes)

**Allocation of places**

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**Additional information**

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**Workload**

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| **Teaching cycle** |
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| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Molecular Materials (Lecture and practical course)** | | | 08-CT-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| Dean of Studies Funktionswerkstoffe (Functional Materials) | | Chair of Chemical Technology of Material Synthesis | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 10 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | By way of exception, additional prerequisites are listed in the section on assessments. | |

**Contents**

This module discusses the theoretical and practical principles of molecular and soft materials.

**Intended learning outcomes**

Students have developed a knowledge of the principles of molecular and soft materials and are able to apply that knowledge to research problems.

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

This module comprises 2 module components. Information on courses will be listed separately for each module component.

- 08-CT-1-122: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 08-CT-2-122: P (no information on SWS (weekly contact hours) and course language available)

**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)

Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 08-CT-1-122:** Molecular Materials (Lecture) Molecular Materials (Lecture)

- 5 ECTS, Method of grading: numerical grade
- presentation (approx. 30 minutes) and a) 1 to 3 written examinations (1 written examination: approx. 90 minutes; 2 written examinations: approx. 60 or 90 minutes each; 3 written examinations: approx. 60 minutes each) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes). Should a module component comprise more than one graded assessment, all assessments will be equally weighted, unless otherwise specified; should the lecturer want to make changes to the way in which assessments are weighted, he or she must do so by two weeks after the start of the course at the latest and must communicate this to students in an appropriate manner.
- Language of assessment: German or English
- Other prerequisites: Admission prerequisite to assessment: successful completion of exercises in the respective classes as specified at the beginning of the course (usually 70% of exercises to be successfully completed) as well as regular attendance of exercises (usually a maximum of 2 incidents of unexcused absence).

**Assessment in module component 08-CT-2-122:** Molecular Materials (Practical course)

- 5 ECTS, Method of grading: (not) successfully completed
- Vortestate (pre-experiment exams, approx. 15 minutes each) and logs (approx. 5 pages each)
- Assessment offered: once a year, winter semester
- Language of assessment: German or English
- Other prerequisites: Admission prerequisite to assessment: regular attendance (minimum 80%) of courses.

**Allocation of places**

Information on the allocation of places will be listed separately for each module component.

- 08-CT-1-122: --
- 08-CT-2-122: Students from the Faculty of Chemistry: no restrictions. Nanostrukturtechnik (Nanostructure Technology): 4. Should there be more than 4 applications from students of Nanostrukturtechnik (Nano-

structure Technology), places will be allocated among these applicants as follows: (1) Places will be allocated by lot. (2) Should there be, within one module component, several courses with a restricted number of places, there will be a uniform regulation for the courses of one module component. In this case, places on all courses of a module component that are concerned will be allocated in a standardised procedure. In this procedure, applicants who already have successfully completed at least one other module component of the respective module will be given preferential consideration. (3) A waiting list will be maintained and places re-allocated as they become available.

**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Functional Materials (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Molecular Materials for Students of Nanostructure Technology** | | | 08-CTO-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| Dean of Studies Funktionswerkstoffe (Functional Materials) | | Chair of Chemical Technology of Material Synthesis | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Admission prerequisite to assessment: successful completion of exercises in the respective classes as specified at the beginning of the course (usually 70% of exercises to be successfully completed) as well as regular attendance of exercises (usually a maximum of 2 incidents of unexcused absence). | |

**Contents**

This module discusses the theoretical and practical principles of molecular and soft materials.

**Intended learning outcomes**

Students have developed a knowledge of the principles of molecular and soft materials and are able to apply that knowledge to research problems.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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)

presentation (approx. 30 minutes) and a) 1 to 3 written examinations (1 written examination: approx. 90 minutes; 2 written examinations: approx. 60 or 90 minutes each; 3 written examinations: approx. 60 minutes each) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes). Should a module component comprise more than one graded assessment, all assessments will be equally weighted, unless otherwise specified; should the lecturer want to make changes to the way in which assessments are weighted, he or she must do so by two weeks after the start of the course at the latest and must communicate this to students in an appropriate manner.
Language of assessment: German or English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Electrochemical Energy Storage and Conversion** | | | 08-EEW-122-m01 |
| **Module coordinator** | | | **Module offered by** |
| holder of the Chair of Chemical Technology of Material Synthesis | | | Chair of Chemical Technology of Material Synthesis |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | Admission prerequisite to assessment: regular attendance of lab course (a maximum of one incident of unexcused absence). | |

**Contents**

Chemistry and application of: battery systems (aqueous and non-aqueous systems such as lead, nickel cadmium and nickel metal hydride, sodium sulphur, sodium nickel chloride, lithium ion accumulators), electrochemical double layer capacitors, redox-flow batteries, fuel cell systems (AFC, PEMFC, DMFC, PAFC, SOFC), solar cells (Si, CIS, CIGS, GaAs, organic and dye solar cell), thermoelectric devices.

**Intended learning outcomes**

Students have developed a knowledge of electrochemical energy storage and conversion and are able to apply that knowledge to research problems.

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

V + P + E (no information on SWS (weekly contact hours) and course language available)

**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)

placement report / fieldwork report / report on practical training / report on practical course / project report / report on technical course (approx. 5 pages) and a) written examination (approx. 90 minutes) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes). Should a module component comprise more than one graded assessment, all assessments will be equally weighted, unless otherwise specified; should the lecturer want to make changes to the way in which assessments are weighted, he or she must do so by two weeks after the start of the course at the latest and must communicate this to students in an appropriate manner.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Master's degree (1 major) Functional Materials (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Material Science 1 (basic introduction)** | | | 08-FS1-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| Dean of Studies Funktionswerkstoffe (Functional Materials) | | Chair of Chemical Technology of Material Synthesis | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | -- | |

**Contents**

This module discusses the fundamental relations between chemical bonding, the structure, the microstructure and the properties of materials.

**Intended learning outcomes**

Students have become familiar with the fundamental relations between chemical bonding, the structure, the microstructure and the properties of materials. They have developed the ability to apply them to research problems.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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) 1 to 3 written examinations (1 written examination: approx. 90 minutes; 2 written examinations: approx. 60 or 90 minutes each; 3 written examinations: approx. 60 minutes each) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German or English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Functional Materials (2012)
Master's degree (1 major) Chemistry (2013)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Material Science 2 (the material groups)** | | | 08-FS2-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| Dean of Studies Funktionswerkstoffe (Functional Materials) | | Chair of Chemical Technology of Material Synthesis | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | -- | |

**Contents**

This module deals with the fabrication and properties of the main material groups.

**Intended learning outcomes**

Students have developed a knowledge of the fabrication and properties of the main material groups and are able to apply that knowledge to research problems.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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) 1 to 3 written examinations (1 written examination: approx. 90 minutes; 2 written examinations: approx. 60 or 90 minutes each; 3 written examinations: approx. 60 minutes each) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German or English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Functional Materials (2012)
Master's degree (1 major) Chemistry (2013)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Chemical Nanotechnology: Analytics and Applications** | | | 08-FS5-101-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Chemical Technology of Material Synthesis | | Chair of Chemical Technology of Material Synthesis | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | -- | |

**Contents**

The module provides an application-oriented introduction to the characterisation methods of nanochemistry and includes practical exercises. It also discusses thermoanalysis, rheological processes and dynamic light scattering. The lecture also offers insights into the applications of nanomaterials in the industrial and technological sectors.

**Intended learning outcomes**

Students have developed an advanced knowledge of sol-gel chemistry and biomineralisation.

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

This module comprises 2 module components. Information on courses will be listed separately for each module component.

- 08-FS5-1-101: V (no information on SWS (weekly contact hours) and course language available)
- 08-FS5-2-101: V (no information on SWS (weekly contact hours) and course language available)

**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)

Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 08-FS5-1-101:** Sol-Gel Chemistry 2

- 2 ECTS, Method of grading: numerical grade
- a) oral examination (approx. 15 minutes) or b) written examination (approx. 45 minutes)

**Assessment in module component 08-FS5-2-101:** Application oriented Characterization of colloidal and polymeric systems

- 3 ECTS, Method of grading: numerical grade
- a) oral examination (approx. 20 minutes) or b) written examination (approx. 45 minutes)

**Allocation of places**

Number of places: 20. Should the number of applications exceed the number of available places, places will be allocated in a standardised procedure among all applicants irrespective of their subjects according to the following quotas: Quota 1 (50% of places): total number of ECTS credits already achieved in the respective degree subject; among applicants with the same number of ECTS credits achieved, places will be allocated by lot. Quota 2 (25% of places): number of subject semesters of the respective applicant; among applicants with the same number of subject semesters, places will be allocated by lot. Quota 3 (25% of places): allocation by lot. In this procedure, applicants who already have successfully completed at least one module component of the respective module will be given preferential consideration. A waiting list will be maintained and places re-allocated as they become available.

**Additional information**

The course is offered as a block course at the end of the semester.

**Workload**

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| **Teaching cycle** |
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| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Master's degree (1 major) Technology of Functional Materials (2010)<br>Master's degree (1 major) Functional Materials (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Chemically and bio-inspired Nanotechnology for Material Synthesis** | | | 08-NT-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| holder of the Chair of Chemical Technology of Material Synthesis | | Chair of Chemical Technology of Material Synthesis | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | -- | |

**Contents**

This module provides an introduction to the synthesis methods of sol-gel chemistry and discusses the methods of analysis used to characterise the generated materials. It also discusses the fundamental principles of biomineralisation and uses examples to introduce students to bio-inspired material synthesis.

**Intended learning outcomes**

Students have developed an advanced knowledge of sol-gel chemistry and biomineralisation.

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

This module comprises 2 module components. Information on courses will be listed separately for each module component.

- 08-NT-1-122: V (no information on SWS (weekly contact hours) and course language available)
- 08-NT-2-122: V (no information on SWS (weekly contact hours) and course language available)

**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)

Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 08-NT-1-122:** Sol-Gel Chemistry 1: Fundamentals

- 2 ECTS, Method of grading: numerical grade
- a) written examination (approx. 45 minutes) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)

**Assessment in module component 08-NT-2-122:** From Biomineralisation to biologically inspired Materials Synthesis

- 3 ECTS, Method of grading: numerical grade
- a) written examination (approx. 45 minutes) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Functional Materials (2012)

Master's degree (1 major) Chemistry (2013)
Master's degree (1 major) Technology of Functional Materials (2010)
Master's degree (1 major) Technology of Functional Materials (2009)
Master's degree (1 major) Functional Materials (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Nanoscale Materials** | | | 08-PCM3-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| lecturer of the seminar "Nanoskalige Materialien" | | Institute of Physical and Theoretical Chemistry | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | -- | |

**Contents**

This module discusses advanced topics in nanoscale materials. It focuses on the structure, properties, fabrication, modern characterisation methods and application areas of nanoscale materials.

**Intended learning outcomes**

Students are able to characterise nanoscale materials. They are able to name analytical methods and application areas of nanoscale materials.

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

S + Ü (no information on SWS (weekly contact hours) and course language available)

**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 (90 minutes) or oral examination of one candidate each (20 minutes) or talk (30 minutes)
Language of assessment: German or English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Master's degree (1 major) Chemistry (2013)
Master's degree (1 major) Chemistry (2010)
Master's degree (1 major) Chemistry (2014)
Master's degree (1 major) Mathematics (2012)
Master's degree (1 major) Computational Mathematics (2012)
Master's degree (1 major) Functional Materials (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Introduction to Computer Science for Students of all Faculties** | | | 10-I-EIN-111-m01 |
| **Module coordinator** | | **Module offered by** | |
| Dean of Studies Informatik (Computer Science) | | Institute of Computer Science | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 10 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Admission prerequisite to assessment: academic requirements to be met in exercises as specified at the beginning of the course. | |

**Contents**

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

**Intended learning outcomes**

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

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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 (80 to 90 minutes) or b) oral examination of one candidate each (approx. 20 minutes) or oral examination in groups of 2 or 3 candidates (30 or 40 minutes respectively)

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Functional Materials (2012)
Master's degree (1 major) Psychology (2012)
Bachelor's degree (1 major, 1 minor) Digital Humanities (Minor, 2012)
Bachelor's degree (2 majors) Digital Humanities (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Computational Mathematics** | | | 10-M-COM-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| Dean of Studies Mathematik (Mathematics) | | Institute of Mathematics | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 4 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

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

**Intended learning outcomes**

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

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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)

project in the form of programming exercises (type and expenditure of time to be specified by the lecturer at the beginning of the course)
Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Economathematics (2012)
Bachelor' degree (1 major) Mathematical Physics (2012)

Bachelor' degree (1 major) Functional Materials (2012)
First state examination for the teaching degree Gymnasium Mathematics (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Modelling and Computational Science** | | | 10-M-MWR-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| Dean of Studies Mathematik (Mathematics) | | Institute of Mathematics | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 10 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Aspects of mathematical modelling of technical or scientific processes. Basic principles of modelling, aspects of scaling the modelling, asymptotic series, classical methods for solving ordinary and partial differential equations, fundamental methods for numerical solution of partial differential equations and the resulting systems of linear equations.

**Intended learning outcomes**

The student masters the fundamental mathematical methods and techniques to simulate processes from natural and engineering sciences on a computer.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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 180 minutes)
if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Mathematical Physics (2012)

Bachelor' degree (1 major) Computational Mathematics (2012)
Bachelor' degree (1 major) Computational Mathematics (2013)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Mathematics 1 and 2 for students in Nanostructure Technology** | | | 10-M-NST12-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| Dean of Studies Mathematik (Mathematics) | | Institute of Mathematics | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 16 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 2 semester | undergraduate | By way of exception, additional prerequisites are listed in the section on assessments. | |

**Contents**

Basics on numbers and functions, sequences and series, elementary functions, differential and integral calculus in one variable, vector calculus, linear maps and systems of linear equations, matrix calculus, eigenvalue theory, differential and integral calculus in several variables, differential equations, Fourier analysis, integral theorems.

**Intended learning outcomes**

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

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

This module comprises 2 module components. Information on courses will be listed separately for each module component.

- 10-M-NST12-1-092: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-NST12-2-092: V + Ü (no information on SWS (weekly contact hours) and course language available)

**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)

Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 10-M-NST12-1-092:** Mathematics 1 for students of Nanostructure Technology
Mathematics 1 for students of Nanostructure Technology

- 8 ECTS, Method of grading: (not) successfully completed
- written examination (approx. 90 to 120 minutes, usually chosen) or oral examination of one candidate each (approx. 20 minutes) or oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

**Assessment in module component 10-M-NST12-2-092:** Mathematics 2 for students of Nanostructure Technology
Mathematics 2 for students of Nanostructure Technology

- 8 ECTS, Method of grading: numerical grade
- written examination (approx. 90 to 120 minutes, usually chosen) or oral examination of one candidate each (approx. 20 minutes) or oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to

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| assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. |
| **Allocation of places** |
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| **Additional information** |
| -- |
| **Workload** |
| -- |
| **Teaching cycle** |
| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Numerical Mathematics 1 for Economathematics** | | | 10-M-NUW-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| Dean of Studies Mathematik (Mathematics) | | Institute of Mathematics | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 10 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

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

**Intended learning outcomes**

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

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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 180 minutes)
if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Economathematics (2012)
Bachelor' degree (1 major) Functional Materials (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Programming course for students of Mathematics and other subjects** | | | 10-M-PRG-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| Dean of Studies Mathematik (Mathematics) | | Institute of Mathematics | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 3 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

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

**Intended learning outcomes**

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

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

P (no information on SWS (weekly contact hours) and course language available)

**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)

project in the form of programming exercises (type and expenditure of time to be specified by the lecturer at the beginning of the course)
Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Economathematics (2012)
Bachelor' degree (1 major) Mathematical Physics (2012)
Bachelor' degree (1 major) Functional Materials (2012)
First state examination for the teaching degree Gymnasium Mathematics (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Computational Physics** | | | 11-A1-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

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

**Intended learning outcomes**

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

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

Only as part of pool of general key skills (ASQ): 15 places. Places will be allocated by lot.

**Additional information**

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**Workload**

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**Teaching cycle**

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

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| **Module appears in** |
| --- |
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2010) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Bachelor' degree (1 major) Mathematical Physics (2009) |
| Bachelor' degree (1 major) Mathematical Physics (2012) |
| Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Electronics** | | | 11-A2-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

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

**Intended learning outcomes**

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

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

Only as part of pool of general key skills (ASQ): 15 places. Places will be allocated by lot.

**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)
Bachelor' degree (1 major) Physics (2012)
Bachelor' degree (1 major) Nanostructure Technology (2012)

Master's degree (1 major) Physics (2011)
Master's degree (1 major) Nanostructure Technology (2011)
Master's degree (1 major) FOKUS Physics (2011)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Laboratory and Measurement Technology** | | | 11-A3-072-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 | Admission prerequisite to assessment: successful completion of approx. 50% of exercises. Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

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

**Intended learning outcomes**

The students have acquired the following transferable skills: Electronic and optical measuring methods in physical metrology, cryogenics and vacuum technology, cryogenics, light sources, spectroscopic methods and measured value acquisition.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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)

**Allocation of places**

Only as part of pool of general key skills (ASQ): 15 places. Places will be allocated by lot.

**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Physics (2007)
Bachelor' degree (1 major) Physics (2010)
Bachelor' degree (1 major) Physics (2009)
Bachelor' degree (1 major) Physics (2012)
Bachelor' degree (1 major) Physics (2008)

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Nanostructure Technology (2008)
Bachelor' degree (1 major) Nanostructure Technology (2007)
Master's degree (1 major) Technology of Functional Materials (2010)
Master's degree (1 major) Technology of Functional Materials (2009)
Master's degree (1 major) Functional Materials (2012)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2008)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Applied Superconduction** | | | 11-ASL-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Physical principles of superconductivity. Application in energy engineering. Instrumental developments. Methods of materials sciences for the calculation of temperature profiles in superconductors.

**Intended learning outcomes**

The students have a basic understanding of superconductivity as a macroscopic quantum phenomenon. They are able to evaluate the contributions of materials sciences to the development of superconductivity. They are able to discuss questions on superconductivity in a scientific manner and to critically question developments of energy technology. Furthermore, they can deal with practical mathematical questions.

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: once a year, winter semester
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)

Bachelor' degree (1 major) Physics (2012)
Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Master's degree (1 major) Mathematics (2010)
Master's degree (1 major) Physics (2010)
Master's degree (1 major) Physics (2011)
Master's degree (1 major) Nanostructure Technology (2011)
Master's degree (1 major) Nanostructure Technology (2010)
Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)
Master's degree (1 major) FOKUS Physics (2010)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Bachelor Thesis Nanostructure Technology** | | | 11-BA-N-072-m01 |
| **Module coordinator** | | **Module offered by** | |
| chairperson of examination committee | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 10 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Mostly independent processing of an experimental, theoretical or engineering task in the field of nanostructure technology, especially according to known procedures and scientific aspects; writing of the Bachelor's thesis.

**Intended learning outcomes**

The students are able to independently work on an experimental, theoretical and engineering task from nanostructure technology under the guidance of a supervisor, especially in accordance with known methods and scientific aspects and to summarise their results in a final paper.

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

no courses assigned

**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 thesis (approx. 25 pages)

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Nanostructure Technology (2008)
Bachelor' degree (1 major) Nanostructure Technology (2007)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Biophysical Measurement Technology in Medical Science** | | | 11-BMT-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

The lecture covers the physical principles of imaging techniques and their application in Biomedicine. The main topics are conventional X-ray technique, computer tomography, imaging techniques of nuclear medicine, ultrasound and MR-tomography. The lecture additionally addresses systems theory of imaging systems and digital image processing.

**Intended learning outcomes**

The students know the physical principles of imaging techniques and their application in Biomedicine. They understand the principles of image generation and are able to explain different techniques and interpret simple images.

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2010) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |
| Master's degree (1 major) Functional Materials (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Image and Signal Processing in Physics** | | | 11-BSV-122-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Periodic and aperiodic signals; principles of discreet and exact Fourier transformation; principles of digital signal and image processing; discretisation of signals/sampling theorem (Shannon); homogeneous and linear filters, convolution product; tapering functions and interpolation of images; the Parsival theorem, correlation and energetic observation; statistical signals, image noise, moments, stationary signals; tomography: Hankel and Radon transformation.

**Intended learning outcomes**

The students have advanced knowledge of digital image and signal processing. They know the physical principles of image processing and are familiar with different methods of signal processing. They are able to explain different methods and to implement them, especially in the field of tomography.

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 (90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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| **Module appears in** |
| --- |
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Image and Signal Processing in Physics** | | | 11-BSV-131-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semesters. | |

**Contents**

Periodic and aperiodic signals; principles of discreet and exact Fourier transformation; principles of digital signal and image processing; discretisation of signals/sampling theorem (Shannon); homogeneous and linear filters, convolution product; tapering functions and interpolation of images; the Parsival theorem, correlation and energetic observation; statistical signals, image noise, moments, stationary signals; tomography: Hankel and Radon transformation.

**Intended learning outcomes**

The students have advanced knowledge of digital image and signal processing. They know the physical principles of image processing and are familiar with different methods of signal processing. They are able to explain different methods and to implement them, especially in the field of tomography.

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

--

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

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)
Bachelor' degree (1 major) Physics (2012)
Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Master's degree (1 major) Physics (2010)
Master's degree (1 major) Physics (2011)
Master's degree (1 major) Nanostructure Technology (2011)
Master's degree (1 major) Nanostructure Technology (2010)
Master's degree (1 major) FOKUS Physics (2010)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Coating Technologies based on Vapour Deposition** | | | 11-BVG-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Physical technical principles of PVD and CVD installations and processes. Coating deposit and layer characterisation. Application of layer materials on an industrial level.

**Intended learning outcomes**

The students have advanced knowledge of coating deposit processes in the gaseous phase and gain insights into their industrial relevance and variety.

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

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**Additional information**

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**Workload**

--

**Teaching cycle**

--

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)

Master's degree (1 major) Nanostructure Technology (2011)
Master's degree (1 major) Functional Materials (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Current Topics in Nanostructure Technology** | | | 11-BXN5-112-m01 |
| **Module coordinator** | | **Module offered by** | |
| chairperson of examination committee | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Approval by examination committee required. | |

**Contents**

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

**Intended learning outcomes**

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

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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. 120 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

--

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Current Topics in Nanostructure Technology** | | | 11-BXN6-112-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 by examination committee required. | |

**Contents**

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

**Intended learning outcomes**

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

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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. 120 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

--

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Current Topics in Nanostructure Technology** | | | 11-BXN8-112-m01 |
| **Module coordinator** | | **Module offered by** | |
| chairperson of examination committee | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 8 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Approval by examination committee required. | |

**Contents**

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

**Intended learning outcomes**

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

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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. 120 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Current Topics in Physics** | | | 11-BXP5-112-m01 |
| **Module coordinator** | | | **Module offered by** |
| chairperson of examination committee | | | Faculty of Physics and Astronomy |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Approval by examination committee required. | |

**Contents**

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

**Intended learning outcomes**

The students have advanced competencies corresponding to the requirements of a module of Experimental or Theoretical Physics of the Bachelor's programme of Nanostructure Technology. They 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 + R (no information on SWS (weekly contact hours) and course language available)

**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. 120 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Language of assessment: German or English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Current Topics in Physics** | | | 11-BXP6-112-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 by examination committee required. | |

**Contents**

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

**Intended learning outcomes**

The students have advanced competencies corresponding to the requirements of a module of Experimental or Theoretical Physics of the Bachelor's programme of Nanostructure Technology. They 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 + R (no information on SWS (weekly contact hours) and course language available)

**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. 120 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Language of assessment: German or English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Current Topics in Physics** | | | 11-BXP8-112-m01 |
| **Module coordinator** | | | **Module offered by** |
| chairperson of examination committee | | | Faculty of Physics and Astronomy |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 8 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Approval by examination committee required. | |

**Contents**

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

**Intended learning outcomes**

The students have advanced competencies corresponding to the requirements of a module of Experimental or Theoretical Physics of the Bachelor's programme of Nanostructure Technology. They 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 + R (no information on SWS (weekly contact hours) and course language available)

**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. 120 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Language of assessment: German or English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Theoretical Electrodynamics** | | | 11-ED-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Theoretical Physics and Astrophysics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 8 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Principles of electrostatics, magnetostatics, Maxwell equations, covariant formulation, electrodynamics and matter

**Intended learning outcomes**

The students have knowledge of the principles of classical electrodynamics and the required calculation methods.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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, for modules with less than 4 ECTS credits approx. 90 minutes; unless otherwise specified)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Mathematics (2012)
Bachelor' degree (1 major) Mathematics (2013)

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Computational Mathematics (2012)
Bachelor' degree (1 major) Computational Mathematics (2013)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Introduction to Nanoscience** | | | 11-EIN-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 6 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 2 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Introduction to the principles of producing, characterising and applying nanostructures.

**Intended learning outcomes**

The students have knowledge of the fundamental properties, technologies, characterising methods and functions of nanostructures.

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

V + S (no information on SWS (weekly contact hours) and course language available)

**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, for modules with less than 4 ECTS credits approx. 90 minutes; unless otherwise specified)

**Allocation of places**

Only as part of pool of general key skills (ASQ): 15 places. Places will be allocated by lot.

**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Functional Materials (2012)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)
No final examination Special study offering (2010)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Principles of Energy Technologies** | | | 11-ENT-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**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)

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2010) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |
| Master's degree (1 major) Functional Materials (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Solid State Spectroscopy** | | | 11-FKS-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Single- and many-particle picture of electrons in solids. Light-matter interaction. Optical spectroscopy. Electron spectroscopy. X-ray spectroscopies.

**Intended learning outcomes**

The students have specific and advanced knowledge in the field of solid-state spectroscopy. They know different types of spectroscopy and their fields of application. They understand the theoretical principles and the current developments in research.

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

| |
|---|
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Mathematics (2012) |
| Master's degree (1 major) Mathematics (2010) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |
| Master's degree (1 major) Computational Mathematics (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Semiconductor Lasers - Principles and Current Research** | | | 11-HLF-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

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

**Intended learning outcomes**

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

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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| **Teaching cycle** |
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| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Master's degree (1 major) Mathematics (2012)<br>Master's degree (1 major) Physics (2010)<br>Master's degree (1 major) Physics (2011)<br>Master's degree (1 major) Nanostructure Technology (2011)<br>Master's degree (1 major) Nanostructure Technology (2010)<br>Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)<br>Master's degree (1 major) FOKUS Physics (2010)<br>Master's degree (1 major) FOKUS Physics (2011)<br>Master's degree (1 major) Computational Mathematics (2012)<br>Master's degree (1 major) Functional Materials (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Semiconductor Physics** | | | 11-HLP-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Advanced examination of crystal bonding and the electronic band structure of semiconductors. Optical excitations and their coupling effects. Electron-phonon coupling. Temperature-dependent transport properties. Quantisation effects of semiconductors with reduced dimensions. (Semi-)magnetic semiconductors.

**Intended learning outcomes**

The students have specific and advanced knowledge in the field of Semiconductor Physics. They know the physical principles of semiconductors and have gained an overview of the important characteristics of semiconductor materials.

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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| **Module appears in** |
| --- |
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Mathematics (2012) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |
| Master's degree (1 major) Computational Mathematics (2012) |
| Master's degree (1 major) Functional Materials (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Semiconductor Nanostructures** | | | 11-HNS-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Semiconductor nanostructures are frequently referred to as "artificial materials". In contrast to atoms, molecules or macroscopic crystals, their electronic, optical and magnetic properties can be systematically tailored by changing their size. The lecture addresses technological challenges in the preparation of semiconductor nanostructures of varying dimensions (2D, 1D, 0D). It provides the basic theoretical concepts to describe their properties, with a focus on optical properties and light-matter coupling. Moreover, it discusses the challenges and concepts of novel optoelectronic and quantum photonic devices based on such nanostructures, including building blocks for quantum communication and quantum computing architectures.

**Intended learning outcomes**

The students know the theoretical principles and characteristics of semiconductor nanostructures. They have knowledge of the technological methods to fabricate such structures, and of their applications to novel photonic devices. They are able to apply their knowledge to problems in this field of research.

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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| **Teaching cycle** |
| --- |
| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Master's degree (1 major) Mathematics (2012)<br>Master's degree (1 major) Mathematics (2010)<br>Master's degree (1 major) Physics (2010)<br>Master's degree (1 major) Physics (2011)<br>Master's degree (1 major) Technology of Functional Materials (2010)<br>Master's degree (1 major) Nanostructure Technology (2011)<br>Master's degree (1 major) Nanostructure Technology (2010)<br>Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)<br>Master's degree (1 major) FOKUS Physics (2010)<br>Master's degree (1 major) FOKUS Physics (2011)<br>Master's degree (1 major) Computational Mathematics (2012)<br>Master's degree (1 major) Functional Materials (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Advanced Seminar Nanostructure Technology** | | | 11-HSN-122-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)** | |
| 4 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Admission prerequisite to assessment: regular attendance and successful preparation of seminar presentation. Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Current issues in advanced topics of nanostructure zechnology..

**Intended learning outcomes**

The students have in-depth knowledge of a specialist field of advanced nanostructure technology. They are able to independently acquire this knowledge and to summarise it in an oral presentation.

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

S (no information on SWS (weekly contact hours) and course language available)

**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 (approx. 30 to 45 minutes) with discussion
Language of assessment: German or English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Introduction to Electron Microscopy** | | | 11-IEM-111-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 4 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

1. Microscopy with light and electrons. 2. Electrons and their interaction with a specimen. 3. Electron diffraction (selected-area ED, convergent beam ED, basics of electron crystallography, comparison with the X-ray diffraction technique). 4. Transmission electron microscopy (the instrument, contrast mechanisms, principles of image formation, imaging of microstructure). 5. Can we see atoms? High-resolution electron microscopy (principle of image formation, image simulation). 6. Scanning electron microscopy (the instrument, contrast mechanisms). 7. Chemical analysis with the electron microscope (energy-dispersive X-ray microanalysis, electron energy loss spectroscopy). 8. Sample preparation. Electron microscopy and complementary techniques.

**Intended learning outcomes**

The students have basic knowledge of modern research methods of electron microscopy up to an atomic level. They know microscoping procedures that are used in practice in labs and the industry as well as electron-microscopic methods for chemical analysis. They are able to evaluate the efficiency of different research methods.

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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| **Teaching cycle** |
| --- |
| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Master's degree (1 major) Physics (2010)<br>Master's degree (1 major) Physics (2011)<br>Master's degree (1 major) Nanostructure Technology (2011)<br>Master's degree (1 major) Nanostructure Technology (2010)<br>Master's degree (1 major) FOKUS Physics (2010)<br>Master's degree (1 major) FOKUS Physics (2011)<br>Master's degree (1 major) Functional Materials (2012)<br>Master's degree (1 major) FOKUS Physics (2006) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Industrial Practical Course Nanostructure Technology** | | | 11-IP-092-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)** | |
| 10 | numerical grade | 11-EIN and 11-KP | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Insights into industrial methods, work processes, goals and production methods. Summary of own experiences and tasks in a report and an oral presentation.

**Intended learning outcomes**

The students have knowledge and practical experience of using a variety of industrial technologies with relevance to nanostructure technology and are able to summarise their experience in a report and an oral presentation.

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

P + S (no information on SWS (weekly contact hours) and course language available)

**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) placement report and b) presentation/seminar presentation (approx. 30 to 90 minutes), weighted 1:4
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Condensed Matter (Quanta, Atoms, Molecules, Solid State Physics)** | | | 11-KM-092-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)** | |
| 16 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 2 semester | undergraduate | -- | |

**Contents**

Quantum phenomena, introduction to Atomic Physics and physical laws of solids. Experimental principles of Quantum Physics. Mathematical formulation of quantum mechanics. Quantum mechanics of hydrogen atoms. Atoms in external fields. Many-electron atoms. Optical transitions and spectroscopy. Laser. Molecules and chemical bonding. Molecule rotations and vibrations. Bonding in crystals. Mechanical properties. Free electron gas (FEG). Crystal structure. The reciprocal lattice. Structure determination. Lattice vibrations (phonons). Thermal properties of insulators. Electrons in a periodic potential.

**Intended learning outcomes**

The students know the basic contexts and principles of quantum phenomena, Atomic Physics and solids (bonding and structure, lattice dynamics, thermal properties, principles of electronic properties (free electron gas)). They are able to apply mathematical methods to the formulation of modern 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)

Kondensierte Materie 1 (Quanten, Atome, Moleküle) (Condensed Matter 1 (Quanta, Atoms, Molecules)): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester)
Kondensierte Materie 2 (Festkörperphysik 1) (Condensed Matter 2 (Solid State Physics)): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (summer semester)

**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)

This module has the following assessment components
1. Topics covered in lectures and exercises in part 1 (Kondensierte Materie 1 (Condensed Matter 1)): written examination (approx. 120 minutes).
2. Topics covered in lectures and exercises in part 2 (Kondensierte Materie 2 (Condensed Matter 2)): written examination (approx. 120 minutes).
3. Topics covered in lectures and exercises in parts 1 and 2: oral examination of one candidate each (approx. 30 minutes, usually chosen) or written examination (approx. 120 minutes).

Assessment component 3 will be offered in German; English if agreed upon with examiner(s).
Successful completion of approx. 50% of practice work each is a prerequisite for admission to assessment components 1 and 2.
To qualify for admission to assessment component 3, students must pass assessment component 1 and/or 2.
Students are highly recommended to attend both courses Kondensierte Materie 1 (Condensed Matter 1) and Kondensierte Materie 2 (Condensed Matter 2). The topics discussed in these two courses will be covered in assessment component 3.
Students must register for assessment components 1 through 3 online (details to be announced).
To pass this module, students must first pass assessment component 1 or 2 and must then pass assessment component 3.
The grade achieved in assessment component 1 or 2 (whichever is better) and the grade achieved in assessment component 3 will each count 50% towards the overall grade awarded for the module.

**Allocation of places**

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**Additional information**

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| **Workload** |
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| **Teaching cycle** |
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| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| **Module appears in** |
| Bachelor' degree (1 major) Mathematics (2012)<br>Bachelor' degree (1 major) Mathematics (2013)<br>Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Bachelor' degree (1 major) Mathematical Physics (2009)<br>Bachelor' degree (1 major) Mathematical Physics (2012)<br>Bachelor' degree (1 major) Computational Mathematics (2012)<br>Bachelor' degree (1 major) Computational Mathematics (2013)<br>Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Classical Physics (Mechanics, Thermodynamics, Waves, Oscillations, Electricity, Magnetism and Optics)** | | | 11-KP-092-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)** | |
| 16 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 2 semester | undergraduate | Bridge course Mathematische Rechenmethoden der Physik (Mathematical Methods of Physics) for first-semester students. | |

**Contents**

Physical laws of mechanics, thermodynamics, vibrations, waves, science of electricity, magnetism, electromagnetic vibrations and waves, radiation and wave optics. Time, room and motion. Physical values. Force and motion. Interactions and central forces. General relativity. Mechanics of rigid bodies. Friction. Vibration and waves. Non-linearity and chaos. Mechanics of non-rigid bodies. Gasses. Thermodynamics. Electrostatics. Electric current. Mechanisms of conduction. Magnetostatics. Electromagnetic induction. Maxwell equations. Science of alternating current. Electromagnetic waves. Geometric optics. Wave optics.

**Intended learning outcomes**

The students understand the basic principles and connections of mechanics, thermodynamics, vibrations, waves, science of electricity, magnetism, electromagnetic vibrations and waves, radiation and wave optics. They are able to apply mathematical methods to the formulation of physical contexts and autonomously apply their knowledge to the solution of mathematical-physical tasks.

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

Klassische Physik 1 (Mechanik, Wellen, Wärme) (Classical Physics 1 (Mechanics, Waves, Heat)): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester)
Klassische Physik 2 (Elektromagnetismus, Optik) (Classical Physics 2 (Electromagnetism, Optics)): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (summer semester)

**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)

This module has the following assessment components
1. Topics covered in lectures and exercises in part 1 (Klassische Physik 1 (Classical Physics 1)): written examination (approx. 120 minutes).
2. Topics covered in lectures and exercises in part 2 (Klassische Physik 2 (Classical Physics 2)): written examination (approx. 120 minutes).
3. Topics covered in lectures and exercises in parts 1 and 2: oral examination of one candidate each (approx. 30 minutes, usually chosen) or written examination (approx. 120 minutes).

Assessment component 3 will be offered in German; English if agreed upon with examiner(s).
Successful completion of approx. 50% of practice work each is a prerequisite for admission to assessment components 1 and 2.
To qualify for admission to assessment component 3, students must pass assessment component 1 and/or 2.
Students are highly recommended to attend both courses Klassische Physik 1 (Classical Physics 1) and Klassische Physik 2 (Classical Physics 2). The topics discussed in these two courses will be covered in assessment component 3.
Students must register for assessment components 1 through 3 online (details to be announced).
To pass this module, students must first pass assessment component 1 or 2 and must then pass assessment component 3.
The grade achieved in assessment component 1 or 2 (whichever is better) and the grade achieved in assessment component 3 will each count 50% towards the overall grade awarded for the module.

**Allocation of places**

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| **Additional information** |
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| **Workload** |
| -- |
| **Teaching cycle** |
| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Mathematics (2012)<br>Bachelor' degree (1 major) Mathematics (2013)<br>Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Bachelor' degree (1 major) Mathematical Physics (2009)<br>Bachelor' degree (1 major) Mathematical Physics (2012)<br>Bachelor' degree (1 major) Computational Mathematics (2012)<br>Bachelor' degree (1 major) Computational Mathematics (2013)<br>Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)<br>No final examination Special study offering (2010) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Laboratory and Measurement Technology in Biophysics** | | | 11-LMB-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

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

**Intended learning outcomes**

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

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2010) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |
| Master's degree (1 major) Functional Materials (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Magnetism** | | | 11-MAG-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Dia- and paramagnetism, exchange interaction, ferromagnetism, antiferromagnetism, anisotropy, domain structure, nanomagnetism, superparamagnetism, experimental methods to measure magnetic properties, Kondo effect.

**Intended learning outcomes**

The students know basic terms, concepts and phenomena of magnetism and measuring methods for magnetic experiments; they are skilled in simple model building and in the formulation of mathematical-physical approaches and are able to apply them to tasks in the stated areas; they have competencies in independently working on problems of these areas; they are able to evaluate the accuracy of observations and analyses.

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| --- |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Mathematics (2010) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Mathematics 3 for students of Physics and Engineering** | | | 11-MPI3-062-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Theoretical Physics and Astrophysics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 8 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Admission prerequisite to assessment: successful completion of approx. 50% of exercises. Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Ordinary and partial differential equations in Physics.

**Intended learning outcomes**

The students have basic mathematical knowledge of dynamic equations and solution methods for common and partial differential equations.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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)

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Physics (2007)
Bachelor' degree (1 major) Physics (2009)
Bachelor' degree (1 major) Physics (2008)
Bachelor' degree (1 major) Technology of Functional Materials (2009)
Bachelor' degree (1 major) Technology of Functional Materials (2010)
Bachelor' degree (1 major) Nanostructure Technology (2010)

Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Nanostructure Technology (2008)
Bachelor' degree (1 major) Nanostructure Technology (2007)
Bachelor' degree (1 major) Functional Materials (2012)
Bachelor' degree (1 major) Technology of Functional Materials (2006)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Mathematics 4 for Students of Physics and Engineering** | | | 11-MPI4-062-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Theoretical Physics and Astrophysics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 8 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Functional analysis and complex analysis.

**Intended learning outcomes**

The students have basic knowledge of mathematics of Hilbert space and the theory of functions of a complex variable as well as the required calculation methods.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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)

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Physics (2007)
Bachelor' degree (1 major) Physics (2009)
Bachelor' degree (1 major) Physics (2008)
Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Nanostructure Technology (2008)
Bachelor' degree (1 major) Nanostructure Technology (2007)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Methods in Surface Spectroscopy** | | | 11-MSS-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 4 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Boundary conditions of experiments: Ultra-high vacuum, surface sensibility, light-matter-interaction, principles of photoelectron spectroscopy (PES), one-particle image of PES, three step model, many-particle effects, line shape, satellites, Fermi liquid, quasiparticles, exemplary systems and spectra, measurements with synchrotron radiation, related experimental methods.

**Intended learning outcomes**

The students know the physical principles and experimental methods of surface spectroscopy. They are able to conduct, evaluate and interpret simple measurements.

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

V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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| **Module appears in** |
| --- |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |
| Master's degree (1 major) FOKUS Physics (2006) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Nanoanalytics** | | | 11-NAN-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

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

**Intended learning outcomes**

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

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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| **Teaching cycle** |
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| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Master's degree (1 major) Physics (2010)<br>Master's degree (1 major) Physics (2011)<br>Master's degree (1 major) Nanostructure Technology (2011)<br>Master's degree (1 major) Nanostructure Technology (2010)<br>Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)<br>Master's degree (1 major) FOKUS Physics (2010)<br>Master's degree (1 major) FOKUS Physics (2011)<br>Master's degree (1 major) Functional Materials (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Nanotechnology in Energy Research** | | | 11-NTE-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 4 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Nanotechnology is of great significance for energy research. Energy efficiency can be heightened in numerous processes or applications by using special functional materials. This module covers special materials, surfaces and structures that have optimised properties due to effects of nanotechnology. It explains the underlying physical contexts. It uses specific materials and components as examples, such as thermal insulation materials, heat accumulators, functional nanoscale layer and particle systems with spectral selective properties, nanoporous vacuum insulations and electrode materials.

**Intended learning outcomes**

The students have specific and advanced knowledge of the application of nanotechnology in the field of energy research. They know methods of nanotechnology to influence the properties of materials and their applications. They are able to apply their knowledge to specific questions.

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Master's degree (1 major) Nanostructure Technology (2011)<br>Master's degree (1 major) Nanostructure Technology (2010) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Physics of Complex Systems** | | | 11-PKS-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Theoretical Physics and Astrophysics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 6 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

1. Theory of critical phenomena in thermal equilibriumt
2. Introduction into the physics out of equilibriumt
3. Entropy production and fluctuationst
4. Phase transitions away from equilibriumt
5. Universalityt
6. Spin glassest
7. Theory of neural networks

**Intended learning outcomes**

The students have specific and advanced knowledge in the field of physics of complex systems. They know the methods of Statistical Physics, Computational Physics and non-linear dynamics, which are used to describe such systems. They are able to work on current research problems in this area.

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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| **Teaching cycle** |
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| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
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| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Bachelor' degree (1 major) Mathematical Physics (2009)<br>Bachelor' degree (1 major) Mathematical Physics (2012)<br>Master's degree (1 major) Mathematics (2010)<br>Master's degree (1 major) Physics (2010)<br>Master's degree (1 major) Physics (2011)<br>Master's degree (1 major) Nanostructure Technology (2011)<br>Master's degree (1 major) Nanostructure Technology (2010)<br>Master's degree (1 major) Mathematical Physics (2012)<br>Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)<br>Master's degree (1 major) FOKUS Physics (2010)<br>Master's degree (1 major) FOKUS Physics (2011) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Physics of Advanced Materials** | | | 11-PMM-132-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**

General properties of various material groups such as liquids, liquid crystals and polymers; magnetic materials and superconductors; thin films, heterostructures and superlattices. Methods of characterising these material groups; two-dimensional layer materials.

**Intended learning outcomes**

The students know the properties and characterising methods of some modern materials.

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)
Bachelor' degree (1 major) Physics (2012)
Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Master's degree (1 major) Physics (2010)
Master's degree (1 major) Physics (2011)
Master's degree (1 major) Nanostructure Technology (2011)
Master's degree (1 major) Nanostructure Technology (2010)
Master's degree (1 major) FOKUS Physics (2010)
Master's degree (1 major) FOKUS Physics (2011)

| Module title | Abbreviation |
|---|---|
| **Mathematical Methods of Physics** | 11-P-MR-092-m01 |

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

| ECTS | Method of grading | Only after succ. compl. of module(s) |
|---|---|---|
| 6 | (not) successfully completed | -- |

| Duration | Module level | Other prerequisites |
|---|---|---|
| 2 semester | undergraduate | -- |

**Contents**

Principles of mathematics and basic calculation methods beyond the school curriculum, especially for the introduction to and preparation of the modules of Theoretical Physics and Classical or Experimental Physics. Repetition of basic knowledge, functions of several real variables, differential equations, linear algebra, vector analysis, other (delta distribution, Fourier transform).

**Intended learning outcomes**

The students have knowledge of the principles of mathematics and elementary calculation methods which are required in Theoretical and Experimental Physics. They are able to apply these methods to simple problems, especially in the field of Physics.

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

Mathematische Rechenmethoden 1 (Mathematical Methods 1): V (2 weekly contact hours) + Ü (1 weekly contact hour), once a year (winter semester)
Mathematische Rechenmethoden 2 (Mathematical Methods 2): V (2 weekly contact hours) + Ü (1 weekly contact hour), once a year (summer semester)

**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)

This module has the following assessment components
1. Topics covered in lectures and exercises in part 1 (Mathematische Rechenmethoden 1 (Mathematical Methods 1)): exercises or talk (approx. 15 minutes, usually chosen) or written examination (approx. 60 minutes)
2. Topics covered in lectures and exercises in part 2 (Mathematische Rechenmethoden 2 (Mathematical Methods 2)): exercises or talk (approx. 15 minutes, usually chosen) or written examination (approx. 60 minutes)

Successful completion of approx. 50% of practice work each is a prerequisite for admission to assessment components 1 and 2.
Students must register for assessment components 1 and 2 online (details to be announced).
To pass this module, students must pass both assessment component 1 and assessment component 2.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

§ 53 (1) 1. a) Physik Mechanik, Wärmelehre, Elektrizitätslehre, Optik, der speziellen Relativitätstheorie
§ 77 (1) 1. a) Physik "Grundlagen der Experimentalphysik"

**Module appears in**

Bachelor' degree (1 major) Physics (2010)

Bachelor' degree (1 major) Physics (2012)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Mathematical Physics (2012)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Laboratory Course Nanostructure Technology B** | | | 11-P-NB-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 4 | (not) successfully completed | 11-P-PA | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

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

**Intended learning outcomes**

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

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

P (no information on SWS (weekly contact hours) and course language available)

**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)

Preparing, performing and evaluating (lab report) the experiments will be considered successfully completed if a Testat (exam) is passed. Experiments that were not successfully completed can be repeated once. Talk (with discussion; approx. 30 minutes) to test the candidate's understanding of the physics-related contents of the module component. 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**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Advanced Laboratory Course Nanostructure Technology C** | | | 11-P-NC-122-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 4 | (not) successfully completed | 11-P-PA and 11-P-NB | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Physical laws of wave optics, Molecular, Atomic and Nuclear Physics and modern measuring methods using special computerised devices with examples from optics and Solid-State Physics.

**Intended learning outcomes**

The students are able to build and almost independently operate advanced experimental setups. They are able to record measuring results in a structured manner, even in case of huge data traffic, and to analyse the results by using error propagation and statistics. They are able to evaluate results, to draw conclusions and to present and discuss them in a scientific paper and a presentation.

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

P (no information on SWS (weekly contact hours) and course language available)

**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)

Preparing, performing and evaluating (lab report) the experiments will be considered successfully completed if a Testat (exam) is passed. Experiments that were not successfully completed can be repeated once. Talk (with discussion; approx. 30 minutes) to test the candidate's understanding of the physics-related contents of the module component. 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**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Lab Course A** | | | 11-P-PA-112-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 | -- | |

**Contents**

Physical laws of mechanics, thermodynamics, science of electricity, types of error, error approximation and propagation, graphs, linear regression, average values and standard deviation, distribution functions, significance tests, writing of lab reports and publications..

**Intended learning outcomes**

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

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

Auswertung von Messungen und Fehlerrechnung (Measurements and Data Analysis): V (1 weekly contact hour) + Ü (1 weekly contact hour), once a year (winter semester)
Beispiele aus Mechanik, Wärmelehre und Elektrik (Examples from Mechanics, Thermodynamics and Electricity, BAM): P (2 weekly contact hours)

**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)

This module has the following assessment components
1. Topics covered in lectures and exercises: written examination (approx. 120 minutes)
2. Lab course: a) Preparing, performing and evaluating the experiments will be considered successfully completed if a Testat (exam) is passed. b) Talk (with discussion) to test the students' understanding of the physics-related contents of the course (approx. 30 minutes).

Successful completion of approx. 50% of practice work is a prerequisite for admission to assessment component 1 .
To pass assessment component 2, students must pass both elements a) and b). Students will be offered one opportunity to retake element a) and/or element b).
Students must register for assessment components 1 and 2 online (details to be announced).
Students must attend Auswertung von Messungen und Fehlerrechnung (Measurements and Data Analysis) before attending Beispiele aus Mechanik, Wärmelehre und Elektrik (Examples from Mechanics, Thermodynamics and Electricity).
To pass this module, students must pass both assessment component 1 and assessment component 2.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

§ 53 (1) 1. a) Physik Mechanik, Wärmelehre, Elektrizitätslehre, Optik, der speziellen Relativitätstheorie

§ 53 (1) 1. c) Physik physikalische Grundpraktika
§ 77 (1) 1. a) Physik "Grundlagen der Experimentalphysik"
§ 77 (1) 1. d) Physik "physikalische Praktika"

**Module appears in**

Bachelor' degree (1 major) Mathematics (2012)
Bachelor' degree (1 major) Mathematics (2013)
Bachelor' degree (1 major) Physics (2012)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Mathematical Physics (2012)
Bachelor' degree (1 major) Computational Mathematics (2012)
Bachelor' degree (1 major) Computational Mathematics (2013)
First state examination for the teaching degree Grundschule Physics (2009)
First state examination for the teaching degree Hauptschule Physics (2009)
First state examination for the teaching degree Realschule Physics (2009)
First state examination for the teaching degree Gymnasium Physics (2009)
First state examination for the teaching degree Mittelschule Physics (2013)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Practical Course Physical Technology of Material Synthesis** | | | 11-PPT-092-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Physical material properties, growth and coating procedures, methods of characterisation and structuring technologies.

**Intended learning outcomes**

The students have knowledge of the practical basics of material characterisation and physical technology for material synthesis.

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

P (no information on SWS (weekly contact hours) and course language available)

**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)

Preparing the experiment will be considered successfully completed if an oral test (duration: approx. 15 minutes) prior to the experiment is passed. Performing and evaluating the experiment will be considered successfully completed if a Testat (exam) is passed. An experiment log (approx. 8 pages) is to be prepared. Each component of the assessment can be repeated once in the respective semester. Only if both components of the assessment have been successfully completed in the same semester will the module component be considered successfully completed.
Assessment offered: once a year, winter semester

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)

Bachelor' degree (1 major) Functional Materials (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Quantum Mechanics II** | | | 11-QM2-092-m01 |
| **Module coordinator** | | | **Module offered by** |
| Managing Director of the Institute of Theoretical Physics and Astrophysics | | | Faculty of Physics and Astronomy |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 8 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

"Quantum mechanics II" constitutes the central theoretical course of the international Master's program in Physics. It builds upon basics which are acquired in the lecture "Quantum mechanics I" of the Bachelor's degree. While the specific emphasis can be adjusted individually, the core topics that are supposed to be covered should include:
1. Second quantisation: Fermions and bosons
2. Band structures of particles in a crystal
3. Angular momentum, symmetry operators, Lie Algebras
4. Scattering theory: Potential scattering, partial wave expansion
5. Relativistic quantum mechanics: Klein-Gordon equation, Dirac equation, Loretz group, fine structure splitting of atomic spectra
6. Quantum entanglement
7. Canonical formalism

**Intended learning outcomes**

The students acquire in-depth knowledge of advanced quantum mechanics and have a thorough understanding of the mathematical and theoretical concepts of the listed topics. They are able to describe or model problems of modern theoretical Quantum Physics mathematically, to solve problems analytically, to use approximation methods and to interpret the results physically. The course is pivotal to subsequent theory courses in Astrophysics, High-Energy Physics and Condensed Matter/Solid-State Physics. The course is mandatory for all Master's students.

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

| **Allocation of places** |
| --- |
| -- |
| **Additional information** |
| -- |
| **Workload** |
| -- |
| **Teaching cycle** |
| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Bachelor' degree (1 major) Mathematical Physics (2009)<br>Bachelor' degree (1 major) Mathematical Physics (2012)<br>Master's degree (1 major) Mathematics (2012)<br>Master's degree (1 major) Mathematics (2010)<br>Master's degree (1 major) Physics (2010)<br>Master's degree (1 major) Physics (2011)<br>Master's degree (1 major) Nanostructure Technology (2011)<br>Master's degree (1 major) Nanostructure Technology (2010)<br>Master's degree (1 major) Mathematical Physics (2012)<br>Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)<br>Master's degree (1 major) FOKUS Physics (2010)<br>Master's degree (1 major) FOKUS Physics (2011)<br>Master's degree (1 major) Computational Mathematics (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Quantum Transport in Semiconductor Nanostructures** | | | 11-QTH-102-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

The lecture addresses the fundamental transport phenomena of electrons in nanostructures. This includes the topics of: ballistic and diffuse transport, electron interference effects, quantisation of conductivity, interaction phenomena between electrons, Coulomb blockade, thermoelectric properties, description of spin-dependent transport phenomena, topological insulators, solid-state quantum computers.

**Intended learning outcomes**

The students have mastered the basics of electronics of nanostructures in theory and practice. They know functions and applications of respective components.

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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| **Module appears in** |
| --- |
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2010) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Technology of Functional Materials (2010) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) FOKUS Physics (2011) |
| Master's degree (1 major) Functional Materials (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Statistics, Data Analysis and Computer Physics** | | | 11-SDC-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 4 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Statistics, data analysis and computer physics.

**Intended learning outcomes**

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

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)
Bachelor' degree (1 major) Physics (2012)

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Mathematical Physics (2009)
Bachelor' degree (1 major) Mathematical Physics (2012)
Master's degree (1 major) Mathematics (2012)
Master's degree (1 major) Mathematics (2010)
Master's degree (1 major) Physics (2010)
Master's degree (1 major) Physics (2011)
Master's degree (1 major) Nanostructure Technology (2011)
Master's degree (1 major) Nanostructure Technology (2010)
Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)
Master's degree (1 major) FOKUS Physics (2010)
Master's degree (1 major) FOKUS Physics (2011)
Master's degree (1 major) Computational Mathematics (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Statistics, Data Analysis and Computer Physics** | | | 11-SDC-131-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 4 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semesters. | |

**Contents**

Statistics, data analysis and computer physics.

**Intended learning outcomes**

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

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Semiconductor Physics and Devices** | | | 11-SPD-102-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Principles of Semiconductor Physics. Introduction to key theories on semiconductors. Components from the areas of electronics and photonics.

**Intended learning outcomes**

The students are familiar with the properties of semiconductors, they have gained an overview of the electronic and phononic band structures of important semiconductors and the resulting electronic, optical and thermal properties. They know the principles of charge transport and are able to apply Poisson, Boltzmann and continuity equations to the solution of questions. They have gained insights into the methods of semiconductor production and are familiar with the methods of planar technology and current developments in this sector, they have a basic understanding of component production. They understand the structure and function of the main components of electronics (diodes, transistor, FET, thyristor, diac, triac), microwave applications (tunnel, impatt, baritt and Gunn diode) and optoelectronics (photo diode, solar cell, light-emitting diode, semiconductor injection laser). They know the realisation possibilities of low-dimensional charge carrier systems on the basis of semiconductors and their technological importance. They are familiar with current developments in the field of components.

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 minutes) or oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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| **Workload** |
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| -- |
| **Teaching cycle** |
| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Master's degree (1 major) Mathematics (2012)<br>Master's degree (1 major) Physics (2011)<br>Master's degree (1 major) Nanostructure Technology (2011)<br>Master's degree (1 major) FOKUS Physics (2011)<br>Master's degree (1 major) Computational Mathematics (2012)<br>Master's degree (1 major) Functional Materials (2012) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Spintronics** | | | 11-SPI-102-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

This lecture covers the basic principles of spin transport, with a particular emphasis on the phenomena of giant magnetoresistance and tunnel magnetoresistance. As a last point, we discuss new phenomena from the field of spin dynamics and current-induced spin phenomena.

**Intended learning outcomes**

The students know the basic principles of spin transport models and the applications of spin transport in information technology. They have gained an overview of current findings in this field (giant magnetoresistance, tunnel magnetoresistance).

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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| **Module appears in** |
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| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2010) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |
| Master's degree (1 major) FOKUS Physics (2006) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Thermodynamics and Economics** | | | 11-TDO-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Theoretical Physics and Astrophysics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 6 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Energy and economic growth, entropy production, emission reduction. Part I describes the role of energy conversion in the development of the universe, the evolution of life and the unfolding of civilisation. In non-equilibrium thermodynamics, the entropy production density shows the relevance of the second law of thermodynamics for ecological damage and resource consumption. Energy conversion, entropy production and natural resources define the technological and ecological boundaries of industrial economic growth. Part 2 analyses how the factors capital, work, energy and creativity produce the goods and services of a national economy and determine economic growth. The productive power of cheap energy by far exceeds that of expensive labour. Within the current system of taxes and social security contributions, this discrepancy between power and costs of production factors leads to job cuts, waste of resources, impoverishment of nations and growing social tensions. The course discusses how factor income taxation can counteract this development. Part 3 includes seminar presentations, comprises the techniques of rational energy use and non-fossil energy use, and introduces the optimisation programme deeco (Dynamic Energy, Emission and Cost Optimization).

**Intended learning outcomes**

The students understand that energy conversion and entropy production are going to play an important role in the world's economic and social development. As an extension of economic theory, the students know the connections between thermodynamics and economy as well as the productive physical basis of modern economies. They are able to apply the acquired knowledge to particular problems.
NOTE: this is the module that was run by Prof. Dr. R. Kümmel, who has now retired. As the module was tailored to his own theory of economy, it has yet to be decided whether we will continue to offer this module.

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

R + V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.
Language of assessment: German, English

| **Allocation of places** |
| --- |
| -- |
| **Additional information** |
| -- |
| **Workload** |
| -- |
| **Teaching cycle** |
| -- |
| **Referred to in LPO I** (examination regulations for teaching-degree programmes) |
| -- |
| **Module appears in** |
| Bachelor' degree (1 major) Physics (2010)<br>Bachelor' degree (1 major) Physics (2012)<br>Bachelor' degree (1 major) Nanostructure Technology (2010)<br>Bachelor' degree (1 major) Nanostructure Technology (2012)<br>Master's degree (1 major) Physics (2010)<br>Master's degree (1 major) Physics (2011)<br>Master's degree (1 major) Nanostructure Technology (2011)<br>Master's degree (1 major) Nanostructure Technology (2010)<br>Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)<br>Master's degree (1 major) FOKUS Physics (2010)<br>Master's degree (1 major) FOKUS Physics (2011) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Thermodynamics and Economics** | | | 11-TDOE-141-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)** | |
| 3 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | graduate | -- | |

**Contents**

Energy and economic growth, entropy production, emission reduction.
Part I describes the role of energy conversion in the development of the universe, the evolution of life and the unfolding of civilisation. The entropy production density of non-equilibrium thermodynamics shows the relevance of the second law of thermodynamics for ecological damage and resource consumption. Energy conversion, entropy production and natural resources define the technological and ecological boundaries of industrial economic growth.
Part 2 analyses how the factors capital, work, energy and creativity produce the goods and services of a national economy and determine economic growth. The productive power of cheap energy by far exceeds that of expensive labour. Within the current system of taxes and social security contributions, this discrepancy between power and costs of production factors leads to job cuts, waste of resources, impoverishment of nations and growing social tensions. The course discusses how factor income taxation can counteract this development.
Part 3 includes seminar presentations, comprises the techniques of rational energy use and non-fossil energy use, and introduces the optimisation programme deeco (Dynamic Energy, Emission and Cost Optimization).

**Intended learning outcomes**

The students understand that energy conversion and entropy production are going to play an important role in the world's economic and social development. As an extension of economic theory, the students know the connections between thermodynamics and economy as well as the productive physical basis of modern economies. They are able to apply the acquired knowledge to particular problems.
NOTE: this is the module that was run by Prof. Dr. R. Kümmel, who has now retired. As the module was tailored to his own theory of economy, it has yet to be decided whether we will continue to offer this module.

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

V (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

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|---|
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2010) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Theoretical Mechanics** | | | 11-TM-092-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Theoretical Physics and Astrophysics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 8 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Newtonian mechanics, Lagrangian and Hamiltonian formalism, conservation laws, limits of classical physics.

**Intended learning outcomes**

The students have knowledge of the principles of classical theoretical mechanics and the required calculation methods.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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, for modules with less than 4 ECTS credits approx. 90 minutes; unless otherwise specified)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Mathematics (2012)
Bachelor' degree (1 major) Mathematics (2013)
Bachelor' degree (1 major) Nanostructure Technology (2012)

Bachelor' degree (1 major) Computational Mathematics (2012)
Bachelor' degree (1 major) Computational Mathematics (2013)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Introduction to Functional Materials** | | | 11-TMS-102-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 5 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Theoretical and practical principles of physical material properties and semiconductor process technology, dielectrics, metals and oxides. Principles of structuring technology, growth and coating procedures.

**Intended learning outcomes**

The students have knowledge of the theoretical and practical principles of physical material properties and technology for material synthesis.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2010)
Bachelor' degree (1 major) Nanostructure Technology (2012)
Bachelor' degree (1 major) Functional Materials (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Theoretical Physics for Students of Nanostructure Technology** | | | 11-TP-N-122-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)** | |
| 16 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 2 semester | undergraduate | -- | |

**Contents**

Physical laws and elementary methods of Theoretical Physics. Mechanics: Newton's laws, physical values and conservation laws, systems of mass points, reference systems, one-dimensional motion, Lagrange equations, applications, Hamiltonian dynamics. Quantum mechanics: Schrödinger equation, one-dimensional quantum mechanics, abstract quantum mechanics (operator formalism), angular momentum, spin. Electrodynamics: Maxwell equations, electrostatics, magnetostatics, dynamics of electromagnetic fields, special relativity. Thermodynamics: Heat, entropy, thermal equilibrium, measurands, level of efficiency, thermodynamic potentials, phase transitions.

**Intended learning outcomes**

The students know the basic principles, contexts and elementary methods of Theoretical Physics, theoretical mechanics, quantum mechanics, thermodynamics, electrodynamics and Statistical Physics.

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

Theoretische Physik 1 (Lehramt, Nanostrukturtechnik) (Theoretical Physics 1 (Teaching Degree, Nanostructure Technology)): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (summer semester)
Theoretische Physik 2 (Lehramt, Nanostrukturtechnik) (Theoretical Physics 2 (Teaching Degree, Nanostructure Technology)): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester)
Statistische Mechanik und Thermodynamik (Statistical Mechanics and Thermodynamics): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester)
Quantenmechanik (Quantum Mechanics): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (summer semester)
Quantenmechanik für FOKUS-Studierende (Quantum Mechanics for FOKUS Students): V (4 weekly contact hours) + Ü (2 weekly contact hours) + T (1 weekly contact hour), once a year (block taught during semester break between summer and winter semester)

**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)

This module has the following assessment components
1. Topics covered in lectures and exercises in part 1 (Theoretische Physik 1 (Theoretical Physics 1)): written examination (approx. 120 minutes, usually chosen) or oral examination of one candidate each (approx. 30 minutes).
2. Topics covered in lectures and exercises in part 2 (Theoretische Physik 2 (Theoretical Physics 2)): written examination (approx. 120 minutes, usually chosen) or oral examination of one candidate each (approx. 30 minutes).
3. Topics covered in lectures and exercises in part 1 (Statistische Mechanik und Thermodynamik (Statistical Mechanics and Thermodynamics)): written examination (approx. 120 minutes, usually chosen) or oral examination of one candidate each (approx. 30 minutes).
4. Topics covered in lectures and exercises in part 2 (Quantenmechanik (Quantum Mechanics)): written examination (approx. 120 minutes, usually chosen) or oral examination of one candidate each (approx. 30 minutes).
5. Topics covered in lectures and exercises in part 2 (Quantenmechanik für FOKUS-Studierende (Quantum Mechanics for FOKUS Students)): written examination (approx. 120 minutes, usually chosen) or oral examination of one candidate each (approx. 30 minutes).
6. Topics covered in lectures and exercises in parts 1 and 2 (assessment in modules Theoretische Physik (Theoretical Physics) 1 and 2): oral examination of one candidate each (approx. 30 minutes, usually chosen) or written examination (approx. 120 minutes).

7. Topics covered in lectures and exercises in parts 1 and 2 (assessment in module Theoretische Physik für Studierende der Nanostrukturtechnik (Theoretical Physics for Students of Nanostructure Technology)): oral examination of one candidate each (approx. 30 minutes, usually chosen) or written examination (approx. 120 minutes).

Successful completion of approx. 50% of practice work each is a prerequisite for admission to assessment components 1 through 5.
To qualify for admission to assessment component 6, students must pass assessment component 1 and/or 2.
To qualify for admission to assessment component 7, students must pass assessment component 3 and/or 4 and/or 5.
Students are highly recommended to attend both courses Theoretische Physik 1 (Theoretical Physics 1) and Theoretische Physik 2 (Theoretical Physics 2) or, respectively, both courses Statistische Mechanik (Statistical Mechanics) and Thermodynamik und Quantenmechanik (Thermodynamics and Quantum Mechanics). The topics discussed in these courses will be covered in assessment component 6 or, respectively, assessment component 7.
Students must register for assessment components 1 through 7 online (details to be announced).
To pass this module, students must first pass assessment component 1 or 2 and must then pass assessment component 6 or students must first pass assessment component 3, 4 or 5 and must then pass assessment component 7.
The grade achieved in assessment component 1 or 2 (whichever is better) or, respectively, in assessment component 3, 4 or 5 (whichever is the best) and the grade achieved in assessment component 6 or, respectively, assessment component 7 will each count 50% towards the overall grade awarded for the module.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

§ 77 (1) 1. c) Physik "Theoretische Physik"

**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Principles of two- and threedimensional Röntgen imaging** | | | 11-ZDR-111-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

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

**Intended learning outcomes**

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

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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| **Module appears in** |
| --- |
| Bachelor' degree (1 major) Physics (2010) |
| Bachelor' degree (1 major) Physics (2012) |
| Bachelor' degree (1 major) Nanostructure Technology (2010) |
| Bachelor' degree (1 major) Nanostructure Technology (2012) |
| Master's degree (1 major) Physics (2010) |
| Master's degree (1 major) Physics (2011) |
| Master's degree (1 major) Nanostructure Technology (2011) |
| Master's degree (1 major) Nanostructure Technology (2010) |
| Master's degree (1 major) FOKUS Physics (2010) |
| Master's degree (1 major) FOKUS Physics (2011) |
| Master's degree (1 major) Functional Materials (2012) |
| Master's degree (1 major) FOKUS Physics (2006) |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Methods for non-destructive Characterization of Materials and Components** | | | 11-ZMB-112-m01 |
| **Module coordinator** | | **Module offered by** | |
| Managing Director of the Institute of Applied Physics | | Faculty of Physics and Astronomy | |
| **ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | |
| 4 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. | |

**Contents**

Methods of non-destructive material and component characterisation.

**Intended learning outcomes**

The students know methods of non-destructive characterisation of materials and components.

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

V + R (no information on SWS (weekly contact hours) and course language available)

**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 or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)
Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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**Module appears in**

Bachelor' degree (1 major) Nanostructure Technology (2012)
Master's degree (1 major) Nanostructure Technology (2011)
Master's degree (1 major) Functional Materials (2012)